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dept.

[Trade analysis series]

An analysis of the structural
steel and plate erection trade.
1966.

AN ANALYSIS
OF THE
STRUCTURAL STEEL
AND
PLATE ERECTION TRADE



PREPARED BY
A NATIONAL COMMITTEE
APPOINTED BY
THE DEPARTMENT OF LABOUR
OTTAWA, CANADA

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Available by mail from the Queen's Printer, Ottawa,
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OTTAWA

Daly Building, Corner Mackenzie and Rideau

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221 Yonge Street

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Æterna-Vie Building, 1182 St. Catherine St. West

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Price

Catalogue No. L39-2666

Price subject to change without notice

ROGER DUHAMEL, F.R.S.C.

Queen's Printer and Controller of Stationery

Ottawa, Canada

1966



1130745

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

GENERAL TABLE OF CONTENTS

INTRODUCTION:

History and Organization
Nature and Scope of the Analysis
Procedure
Purpose and Use of the Analysis

DIVISION OF THE ANALYSIS:

GENERAL TRADE PRACTICE

BLOCK	1: Layout Procedures	Page	1
	2: Trade Tools and Procedures		8
	3: Rope and Tackle		27
	4: Scaffold and Falsework		31
	5: Erection Equipment		57
	6: Erection Techniques		91
	7: Fastening Techniques		101
	8: Inspection and Testing		120



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AN ANALYSIS OF THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- INTRODUCTION -

HISTORY AND ORGANIZATION

The first national conference on apprenticeship in trades and industries held at Ottawa, in May 1952, recommended that the federal Government be requested to cooperate with provincial apprenticeship committees and officials in preparing analyses of a number of skilled occupations.

In implementing the above recommendation the Technical and Vocational Training Branch of the federal Department of Labour appointed a committee of four persons to prepare an analysis of the Structural Steel and Plate Erection Trade. Representation on this committee was predicated on the need to cover all aspects of the trade and the consideration of unique regional requirements. The committee was organized in April 1963 and included:

- J.D. Abson - Structural Superintendent,
Dominion Structural Steel Division,
Canada Iron Foundries Limited.
- E.P. Carthes - Construction Manager,
Horton Steel Works Limited.
- D.J. Jamieson - Consulting Engineer,
Vancouver, British Columbia.
- R.C. Harris - Construction Manager,
Dominion Bridge Company, Limited.

This committee was convened and directed by Mr. C.L. Bratt, Training Consultant (Curriculum), Technical and Vocational Training Branch, Department of Labour, Ottawa.

NATURE AND SCOPE OF THE ANALYSIS

Out of a trade that was traditionally more concerned with the physical prowess of the journeyman, rather than the acquisition and application of knowledge, there has developed, in recent years, a body of knowledge and skill which require more formalized training if the increased demands of the Canadian Construction Industry for skilled structural steel and plate erection is to be met. While physical prowess is necessarily a prerequisite of this trade, new structural designs and erection techniques, together with the development of new structural and plate steels, have given impetus to industry and education for the introduction of formal apprenticeship training programs and upgrading training for journeymen currently engaged in this occupation. The purpose of this analysis then, is to set forth this body of knowledge and skills, from which courses of study can be established and apprenticeship and upgrading training programs developed.

In the preparation of the analysis, the national committee recognized the mobility associated with workers in this occupation. Therefore all facets of the trade as it is practiced in all provinces of Canada were incorporated into the text. However, there are some unique regional requirements which the committee felt could not, justifiably, be dealt with in a document such as this.

While it is possible to cover all facets of the trade in this analysis, there are certain subject areas such as theory of structures and project planning which are generally beyond the scope of the tradesman. Nevertheless, a fundamental understanding of these subjects is considered essential, in order to give a "raison d'être" to some of the functions of the trade. For that reason, reference has been made to these subjects wherever applicable.

Safety "per se" has not been dealt with in this analysis except where specific hazards exist. Nonetheless, it is tacitly implied that a "well-trained workman is a safe workman". Safety is a function of everyone in the job organization, therefore the requirements of a qualified journeyman are such that he has a sound knowledge of accident prevention and first aid. Of equal importance is a basic knowledge of job planning to enable the journeyman to coordinate his work with other tradesmen. Finally, it must be stressed that in order for a man to work adequately he must be dressed adequately. It is axiomatic that good work clothing is safe work clothing and on the choice of work apparel may rest the safety of the wearer.

It should be further recognized that the Structural Steel and Plate Erection trade is not static and that some preparation must be made for future requirements of the trade. For that reason there are many subjects introduced in the analysis which may not have much in common with present journeyman skills. Such topics as surveying, welding tests and procedures, applied mathematics and science may be quite beyond the scope of the present day journeyman. However, many of today's apprentices will be tomorrow's foremen and facility with all these subjects will enable him to meet the ever increasing demands of the trade with confidence and ability. In conclusion it must be stressed that the ironworker 'sic' structural steel and plate erector, has a reputation for ingenuity, and that the apprentice should be given every opportunity to exercise his imagination in the solution of physical problems.

PROCEDURE

The development of this analysis was undertaken by the committee on the basis of first establishing a broad outline of the occupational requirements. Then each member of the committee undertook to prepare certain sections of the work. As the work proceeded, proof copies were circulated between the members so that the benefit of all opinions were available throughout. This procedure was adopted to ensure the validity and completeness of the finished project.

To ensure that the final result would be acceptable throughout Canada, draft copies were distributed widely to industry, union officials and Provincial Vocational Education and Apprenticeship Authorities for critical comment. Suggestions emanating from these sources were reviewed and any valid changes incorporated into the text.

PURPOSE AND USE OF THE ANALYSIS

It should be emphasized that this is not a course of study and it is not intended that the functions be mastered in the sequence shown. The analysis is recommended as a basis of instruction in industry and in trade schools and institutes, as a guide to foremen or supervisors for on-the-job training and as a basis for evaluating previous experience.

Officials of the federal Department of Labour wish to express their sincere appreciation to the representatives of the various organizations who attended the initial meeting of the National Committee and contributed to the preparation of this analysis, A.G. Asplin, President of Horton Steel Works Limited, P.E. Savage, Vice-President and Manager, Engineering and Construction services and W.D. Jewett, General Manager, Vancouver Branch of Dominion Bridge Company Limited and Dominion Structural Steel Division of Canada Iron Foundries Limited for releasing senior members of their staffs to participate as members of the National Committee. Also, for the assistance of Cliff C. Cooper, General Organizer and the Brotherhood of the International Association of Bridge, Structural and Ornamental Iron Workers, and the interest and help of the Provincial Directors of Apprenticeship and Vocational Education.

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE
- GENERAL TRADE PRACTICE

BLOCK 1: Layout Procedures

TABLE OF CONTENTS

UNIT 1: Survey Instruments	Page 2
2: Lines and Grades	4
3: File Fabrication Layout	6

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE
- GENERAL TRADE PRACTICE -

BLOCK 1: Layout Procedures

UNIT 1: Survey Instruments

OPERATIONS	KNOWLEDGE
1. Locating and setting up instrument	<ul style="list-style-type: none">(a) Interpretation of drawings and specifications to determine:<ul style="list-style-type: none">(i) elevation(ii) orientation(iii) grout allowance(b) Type, purpose and characteristics of survey instruments:<ul style="list-style-type: none">(i) dumpy levels(ii) transits(c) Considerations when locating instrument:<ul style="list-style-type: none">(i) orientation(ii) stability(d) Procedure for locating instrument with reference to bench marks and transit hubs(e) Methods of setting up and adjusting instruments(f) Importance of properly securing tripod legs(g) Effect of improper techniques when using instruments(h) Results of improper adjustment or damage to instruments(i) Care and storage of instruments(j) Mathematics:<ul style="list-style-type: none">(i) linear and angular measurement to calculate elevation, distance and direction(ii) conversion of decimal and fractional values(k) Science:<ul style="list-style-type: none">(i) simple optical instruments(ii) reflection and refraction of light

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 1: Layout Procedures

UNIT 1: Survey Instruments

OPERATIONS

KNOWLEDGE

2. Sighting and Reading

- (a) Types, purpose and function of targets:
 - (i) levelling rod
 - (ii) point sights
 - (iii) plumb-bob
- (b) Types, purpose and use of levelling rods:
 - (i) Philadelphia
 - (ii) Frisco
 - (iii) improvised
- (c) Characteristics and interpretation of rod calibrations
- (d) Considerations in the selection and use of targets
- (e) Effects of improper handling of rod
- (f) Techniques of sighting, reading and recording when using:
 - (i) level
 - (ii) transit
- (g) Characteristics and use of hand signals
- (h) Factors affecting accurate sighting and reading:
 - (i) cumulative error
 - (ii) refraction of light
 - (iii) thermal expansion and contraction
- (i) Care and storage of levelling rods
- (j) Mathematics:
 - (i) linear and angular measurement to calculate elevation, distance and direction
 - (ii) conversion of decimal and fractional values
 - (iii) ratio and proportion to determine cumulative error
 - (iv) relationships and calculation of values between arcs, chords and angles
- (k) Science:
 - (i) refraction of light
 - (ii) thermal expansion and contraction

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 1: Layout Procedures

UNIT 2: Lines and Grades

OPERATIONS

KNOWLEDGE

1. Transferring lines and grades to structure

- (a) Interpretation of drawings and specifications to determine:
 - (i) elevation
 - (ii) orientation
 - (iii) grout allowance
- (b) Types, features and use of linear measuring devices:
 - (i) rules
 - (ii) tapes
 - (iii) flexible rules
 - (iv) steel squares
- (c) Types, features and interpretation of calibrations of:
 - (i) tapes
 - (ii) rules
 - (iii) steel square
- (d) Procedures for using:
 - (i) tapes
 - (ii) rules
 - (iii) steel squares
- (e) Conditions affecting accurate measurement with tapes:
 - (i) sag
 - (ii) expansion and contraction
- (f) Importance of holding tape horizontal when taking horizontal measurements
- (g) Establishment of lines and grades on structure using:
 - (i) transit and level
 - (ii) chalk line and plumb-bob
 - (iii) steel tape and square
 - (iv) carpenter's level and water pots
 - (v) piano wire and trammels
- (h) Methods of establishing points on structure from:
 - (i) lead plugs
 - (ii) batter boards
 - (iii) transit hubs
 - (iv) bench marks
 - (v) punch marks
- (i) Method of setting lead plugs
- (j) Procedures for constructing and locating batter boards
- (k) Techniques for checking anchor bolt layout
- (l) Procedures for setting shims

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 1: Layout Procedures

UNIT 2: Lines and Grades

OPERATIONS

KNOWLEDGE

1. Transferring lines and
grades to structure
(cont'd)

- (m) Methods of checking work
- (n) Effects of error in measurement
- (o) Mathematics:
 - (i) linear and angular measurement to
calculate elevation, distance and
direction
 - (ii) conversion of decimal and fractional
values
 - (iii) relationships and calculation of
values between arcs, chords and angles
 - (iv) ratio and proportion to determine
cumulative error
- (p) Science:
 - (i) elementary scientific measurement

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE
- GENERAL TRADE PRACTICE -

BLOCK 1: Layout Procedures

UNIT 3: Field Fabrication Layout

OPERATIONS

KNOWLEDGE

1. Laying out structural steel

- (a) Interpretation of drawings, specifications and bills of material to determine:
 - (i) type and quantity of material
 - (ii) working lines and working points
 - (iii) fabrication allowances
- (b) Interpretation and use of relevant handbooks and codes to determine:
 - (i) erection requirements
 - (ii) terminology
 - (iii) symbols
 - (iv) identification of plate and structural shapes
- (c) Factors determining type of layout
- (d) Techniques employed in laying out structural steel components
- (e) Types, features and use of layout tools
- (f) Methods of making and using templates:
 - (i) cardboard
 - (ii) wood
 - (iii) metal
- (g) Considerations when ordering materials with particular reference to:
 - (i) stock lengths
 - (ii) economy
- (h) Use of working lines and working points
- (i) Use of tables of slopes and risers
- (j) Method of checking layout before cutting
- (k) Effects of taking measurements off structure
- (l) Mathematics:
 - (i) linear and angular measurements as applied to layout
 - (ii) use of Smolleys tables for tabular solution of Pythagorean theorem
 - (iii) geometric construction
 - (iv) graphical solution of triangles
- (m) Science:
 - (i) elementary scientific measurement

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 1: Layout Procedures

UNIT 3: Field Fabrication Layout

OPERATIONS

KNOWLEDGE

2. Laying out platework

- (a) Interpretation of drawings, specifications and bills to determine:
 - (i) type and quantity of material
 - (ii) type of fabrication
- (b) Types, characteristics and identification of:
 - (i) carbon steel plate
 - (ii) gauge material
 - (iii) stainless material
- (c) Types, features and use of layout tools
- (d) Method of locating and checking centre of cylindrical vessel
- (e) Techniques of layout on cylindrical, spherical, conical and curved surfaces
- (f) Application of shrinkage allowances in welded fabrication layout
- (g) Methods of checking layout on plane and curved surfaces
- (h) Methods of making and using templates:
 - (i) cardboard
 - (ii) wood
 - (iii) metal
- (i) Procedures for laying out diameters of large circles
- (j) Mathematics:
 - (i) calculation of distances from straight and curved datum lines
 - (ii) geometrical constructions for layout of curved and ruled surfaces
 - (iii) calculation of angles, chords and arcs
 - (iv) use of mathematical table for properties of circle
 - (v) use of Smolleys tables for solution of triangles
- (k) Science:
 - (i) elementary scientific measurement
 - (ii) thermal expansion and contraction

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE
- GENERAL TRADE PRACTICE -

BLOCK 2: Trade Tools and Procedures

TABLE OF CONTENTS

UNIT 1: Non-Cutting Hand Tools	Page 9
2: Hand Cutting Tools	14
3: Portable Air Tools	19
4: Portable Electric Tools	23
5: Miscellaneous Tools and Procedures	25

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 2: Trade Tools and
Procedures

UNIT 1: Non-Cutting Hands Tools

OPERATIONS

KNOWLEDGE

1. Selecting and using
wrenches

- (a) Types and uses of wrenches:
 - (i) structural
 - (ii) adjustable
 - (iii) open end
 - (iv) socket
 - (v) box
 - (vi) Allen
- (b) Types and uses of pipe wrenches:
 - (i) Stillson
 - (ii) chain tongs
- (c) Types and uses of miscellaneous wrenches and accessories:
 - (i) torque wrenches
 - (ii) tee wrenches
 - (iii) extensions, universals and ratchets for socket wrenches
 - (iv) slugging wrenches
- (d) Methods of aligning connecting members with a structural wrench
- (e) Determination of left and right handed threads
- (f) Use of belts and scabbards for carrying wrenches
- (g) Hazards in improper use of structural wrenches
- (h) Results of improper fit of wrench
- (i) Calibration of torque wrenches
- (j) Care and maintenance of wrenches and appurtenances
- (k) Science:
 - (i) mechanical advantage of simple machines
 - (ii) levers
 - (iii) screw jack

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 2: Trade Tools and
Procedures

UNIT 1: Non-Cutting Hand Tools

OPERATIONS

KNOWLEDGE

2. Selecting and using
hammers

- (a) Types, features and use of hammers:
 - (i) sledge
 - (ii) ball peen
 - (iii) single jack
 - (iv) spike mauls
 - (v) claw hammer
 - (vi) sparkless
- (b) Correct method of hanging a hammer
- (c) Consideration of weight and balance in selection of a hammer
- (d) Correct stance, grip and swing for various types of hammer
- (e) Materials for hammers
- (f) Results of striking one hammer on another
- (g) Method of tightening a handle in a hammer head
- (h) Science:
 - (i) momentum
 - (ii) levers

3. Selecting and using pins

- (a) Types, characteristics and function of pins:
 - (i) drift
 - (ii) bull
 - (iii) wedge
- (b) Procedures for using drift pins:
 - (i) in joint alignment
 - (ii) in development of strength of joint
- (c) Results of improper use of drift pins
- (d) Techniques for use of bull pins:
 - (i) in fairing up joints
 - (ii) in springing plates
- (e) Hazards in improper use of bull pins
- (f) Use of wedge pins in tank erection
- (g) Procedures for installing large cylindrical pins in:
 - (i) bridges
 - (ii) derricks
 - (iii) other applications
- (h) Science:
 - (i) yield strength
 - (ii) stresses - compressive and shear
 - (iii) fits and clearances

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 2: Trade Tools and
Procedures

UNIT 1: Non-Cutting Hand Tools

OPERATIONS

KNOWLEDGE

4. Selecting and using vises
and clamps

- (a) Types and uses of vises:
 - (i) bench
 - (ii) swivel
 - (iii) pipe
 - (iv) quick action
- (b) Types, features and use of clamps:
 - (i) C clamps
 - (ii) bar type clamps
 - (iii) template clamps
 - (iv) plate clamps
 - (v) beam clamps
- (c) Methods of holding work in vises:
 - (i) regular shapes
 - (ii) irregular shapes
 - (iii) large, heavy pieces
- (d) Method of protecting work in vise:
 - (i) soft jaws
 - (ii) ground jaws
 - (iii) copper and lead softeners
- (e) Results of careless holding techniques
- (f) Care and maintenance of vises and clamps
- (g) Science:
 - (i) inclined plane
 - (ii) screw jack
 - (iii) law of levers

5. Selecting and using
leverage tools

- (a) Types and use of connecting bars
- (b) Types and uses of crowbars, track bars and peavies
- (c) Characteristics and use of railway car movers
- (d) Results of improper use of leverage tools
- (e) Science:
 - (i) levers

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 2: Trade Tools and
Procedures

UNIT 1: Non-Cutting Hand Tools

OPERATIONS

KNOWLEDGE

- | | |
|-------------------------------------|--|
| 6. Selecting and using hand levels | (a) Types and uses of hand levels: <ul style="list-style-type: none">(i) carpenters level(ii) chalk line level(iii) machinists level(iv) shaft level(v) Abney level (b) Results of improper use of levels
(c) Care and maintenance of levels |
| 7. Selecting and using pliers | (a) Types, sizes and use of pliers: <ul style="list-style-type: none">(i) lineman(ii) slip joint(iii) long nose(iv) side, diagonal and end cutters (b) Care, maintenance and storage of pliers
(c) Science: <ul style="list-style-type: none">(i) mechanical advantage of simple machines(ii) law of levers |
| 8. Selecting and using screwdrivers | (a) Types, sizes and use of screwdrivers: <ul style="list-style-type: none">(i) regular(ii) Phillips(iii) Robertson(iv) ratchet (b) Correct method of using screwdrivers
(c) Results of improper fit of screwdrivers
(d) Care and maintenance of screwdrivers
(e) Science: <ul style="list-style-type: none">(i) law of levers(ii) effect of torque |
| 9. Selecting and using plumb-bobs | (a) Types and applications for plumb-bobs
(b) Techniques for using plumb-bobs
(c) Methods of dampening swinging plumb-bobs
(d) Limitations on use of plumb-bobs
(e) Applications and use of optical plummet and collimator |

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE
- GENERAL TRADE PRACTICE -

BLOCK 2: Trade Tools and
Procedures

UNIT 1: Non-Cutting Hand Tools

OPERATIONS

KNOWLEDGE

10. Using air hose wire
tightening clamp

- (a) Methods of using tightening clamp in repair
of air hose
- (b) Features of wire tightener
- (c) Factors affecting choice of wire:
 - (i) type of connection
 - (ii) pressure in hose

11. Selecting and using
punches

- (a) Types, features and use of punches:
 - (i) centre punches
 - (ii) drift punches
- (b) Techniques for gripping and striking punches
- (c) Hazards in incorrect use of punches
- (d) Considerations in the selection of correct
size of punch and hammer
- (e) Methods of reconditioning punches

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 2: Trade Tools and
Procedures

UNIT 2: Hand Cutting Tools

OPERATIONS	KNOWLEDGE
<hr/>	
1. Busting out rivets	(a) Types and methods of use of rivet busters: (i) busting bars (ii) round nose busters (iii) side cutters (b) Procedures for busting out rivets (c) Characteristics and use of backing out punches and bars (d) Effects of improper techniques in busting out rivets (e) Science: (i) stresses - shear, tensile and compressive
2. Selecting and using cold chisels	(a) Types and uses of cold chisels: (i) flat (ii) cape (iii) diamond point (iv) round nose (v) flux scalers (vi) sparkless (b) Procedures for chiselling: (i) in a vise (ii) in place (c) Importance of correct cutting angle (d) Methods of sharpening chisels: (i) filing (ii) grinding (e) Personal protection in use of cold chisels (f) Science: (i) hardening and tempering of steel

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE
- GENERAL TRADE PRACTICE -

BLOCK 2: Trade Tools and
Procedures

UNIT 2: Hand Cutting Tools

OPERATIONS

KNOWLEDGE

4. Selecting and using
handsaws

- (a) Types, features and uses of handsaws
 - (i) hacksaws
 - (ii) wood cutting saws
 - (iii) trepanning saws
- (b) Types and uses of hacksaw blades:
 - (i) flexible edge-hard
 - (ii) alloy
 - (iii) fine, medium, coarse pitch teeth
- (c) Types and uses of woodcutting handsaws:
 - (i) rip
 - (ii) crosscut
 - (iii) two man timber crosscut saw
 - (iv) bucksaw
- (d) Methods of holding work when handsawing metal or wood
- (e) Care and maintenance of hand saws

5. Selecting and using files

- (a) Types, features and methods of use of files:
 - (i) flat
 - (ii) round
 - (iii) square
 - (iv) triangular
 - (v) halfround
- (b) Types and uses of file cuts:
 - (i) single
 - (ii) double
 - (iii) bastard
- (c) Filing procedures and techniques:
 - (i) profile
 - (ii) flat
 - (iii) draw
 - (iv) sharpening
- (d) Care and maintenance of files
- (e) Results of improper care of files
- (f) Science:
 - (i) heat treatment of steels

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE
- GENERAL TRADE PRACTICE -

BLOCK 2: Trade Tools and
Procedures

UNIT 2: Hand Cutting Tools

OPERATIONS	KNOWLEDGE
6. Selecting and using metal cutting snips	(a) Types, features and use of snips: (i) straight snips (ii) duck-billed snips (iii) curved snips (b) Factors affecting selection of snips: (i) type of material (ii) thickness of material (iii) shape of cut (c) Care and maintenance of snips (d) Science: (i) levers (ii) stresses - shear, compressive and tensile
7. Selecting and using axes	(a) Types, features and uses of axes: (i) pole (ii) bench (iii) double bitted (iv) broad (v) hatchets (b) Method of sharpening axes (c) Method of hanging axe heads (d) Correct grip and stance when using an axe (e) Results of incorrect use of an axe
8. Selecting and using an adze	(a) Types, features and uses of adze: (i) framing (ii) docking (iii) shipwrights (b) Method of sharpening an adze (c) Method of hanging an adze head (d) Importance of correct stance and grip in using an adze (e) Results of improper use of an adze (f) Care and maintenance of an adze

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE
- GENERAL TRADE PRACTICE -

BLOCK 2: Trade Tools and
Procedures

UNIT 2: Hand Cutting Tools

OPERATIONS	KNOWLEDGE
9. Selecting and using wood boring tools	(a) Types, features and uses of wood boring equipment: (i) braces and wimbles (ii) bits and augers (b) Methods of starting holes (c) Techniques for keeping bit or auger free in long holes (d) Procedures for sharpening bits and augers (e) Method of boring holes true to line (f) Care and maintenance of braces, bits and augers
10. Selecting and using wood chisels	(a) Types, features and uses of wood chisels (b) Use of a slick in heavy timber framing (c) Procedures for sharpening chisels (d) Care and maintenance of wood chisels
11. Selecting and using flame cutting equipment	(a) Types, methods and uses of flame cutting equipment: (i) oxy-acetylene (ii) oxy-hydrogen (iii) oxy-natural gas (iv) oxy-propane (b) Factors affecting choice of cutting tips (c) Importance of having clean metal when flame cutting (d) Importance of correct pressure regulation (e) Importance of correct tip size (f) Hazards in flame cutting (g) Importance of eye protection when flame cutting (h) Correct set-up of bottles and gauges (i) Procedures for minimizing danger of fire (j) Hazard presented by oil in presence of oxygen

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE
- GENERAL TRADE PRACTICE -

BLOCK 2: Trade Tools and
Procedures

UNIT 2: Hand Cutting Tools

OPERATIONS

KNOWLEDGE

12. Selecting and using
carbon arc cutting
equipment

- (a) Types and methods of use of arc cutting equipment:
 - (i) conventional using air
 - (ii) conventional using oxygen
 - (iii) underwater
- (b) Factors affecting choice of electrodes:
 - (i) type and thickness of material
 - (ii) code requirements
 - (iii) current
- (c) Techniques of carbon arc cutting
- (d) Care and maintenance of carbon arc equipment
- (e) Techniques of underwater cutting
- (f) Topside procedures for underwater cutting
- (g) Hazards of improper techniques in underwater cutting
- (h) Importance of adequate air (oxygen) supply in carbon arc cutting
- (i) Science:
 - (i) amperage, voltage, resistance
 - (ii) elementary circuitry

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 2: Trade Tools and
Procedures

UNIT 3: Portable Air Tools

OPERATIONS

KNOWLEDGE

1. Selecting and using impact
wrenches

- (a) Types and uses of impact wrenches
- (b) Types, function and characteristics of impact wrench chucks:
 - (i) spline drive
 - (ii) square drive
- (c) Procedures for using impact wrenches
- (d) Importance of correct air supply
- (e) Lubrication and simple maintenance procedures
- (f) Science:
 - (i) work, energy, power
 - (ii) gas laws - P, V, T
 - (iii) properties of air

2. Drilling and reaming

- (a) Types and uses of air motors
- (b) Factors affecting choice of air motors:
 - (i) directional
 - (ii) reversible
- (c) Procedures for drilling using air drills
- (d) Techniques of long hole reaming
- (e) Characteristics and use of drill stands
- (f) Taper shank drills - their chucks, adapters and other drives
- (g) Types and characteristics of drills and reamers for:
 - (i) mild steels
 - (ii) alloy steels
- (h) Characteristics and methods of using drill extensions
- (i) Method of drilling out frozen pins
- (j) Care and maintenance of air motors and drills
- (k) Effect of improper air supply on output
- (l) Science:
 - (i) gas laws - P, V, T
 - (ii) properties of air
 - (iii) work, energy, power

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 2: Trade Tools and
Procedures

UNIT 3: Portable Air Tools

OPERATIONS	KNOWLEDGE
3. Selecting and using air hammers	(a) Types, features and uses of air hammers (b) Procedures for using air hammers in: (i) rivetting (ii) chipping (iii) busting rivets (iv) knocking out rivets (v) driving spikes (vi) driving pins (vii) caulking (c) Care and maintenance of air hammers (d) Lubrication of air hammers (e) Importance of correct air supply (f) Hazards in improper use of air hammers (g) Science: (i) properties of air (ii) work, energy, power
4. Rolling tubes	(a) Types and features of tube rolls (b) Factors to consider in choosing air motors (c) Results of improper use of tube rolls: (i) cutting tubes (ii) galling and burning (d) Adaption of motor for use with tube cutter (e) Connection of air supply to tube roller motor (f) Care and maintenance of tube rollers (g) Science: (i) stresses - tensile, compressive, shear (ii) yield strength (iii) properties of air

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 2: Trade Tools and
Procedures

UNIT 3: Portable Air Tools

OPERATIONS

KNOWLEDGE

5. Grinding and power
brushing

- (a) Types, features and use of air motors for
brushing and grinding:
 - (i) straight shank
 - (ii) right angle drive
- (b) Types, features and use of grinding wheels
- (c) Types, features and use of power brushes
- (d) Factors governing choice of grinding wheels
and brushes:
 - (i) material
 - (ii) nature of work
 - (iii) hazards in work area
- (e) Care and maintenance of air grinders and
appurtenances
- (f) Importance of eye protection
- (g) Science:
 - (i) properties of air
 - (ii) abrasives

6. Selecting and using rock
drills and paving breakers

- (a) Types, features and use of rock drills and
paving breakers
- (b) Factors affecting choice of rock drills and
paving breakers
- (c) Importance of adequate air supply
- (d) Necessity of proper lubrication
- (e) Factors affecting choice of steels
- (f) Care and maintenance of drills and steels
- (g) Science:
 - (i) properties of air

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 2: Trade Tools and
Procedures

UNIT 3: Portable Air Tools

OPERATIONS

KNOWLEDGE

- | | |
|---|--|
| 7. Selecting and using wood boring machines | <ul style="list-style-type: none">(a) Types, features and uses of wood boring machines(b) Hazards in improper use of wood boring machines(c) Importance of adequate air supply(d) Lubrication, care and maintenance of wood boring machines(e) Techniques of boring holes true and to line:<ul style="list-style-type: none">(i) across grain(ii) parallel to grain(f) Techniques in clearing hole of chips:<ul style="list-style-type: none">(i) use of soap on auger(ii) regular withdrawal of auger(g) Science:<ul style="list-style-type: none">(i) properties of air |
| 8. Selecting and using air operated timber saws | <ul style="list-style-type: none">(a) Types, features and use of air operated saws:<ul style="list-style-type: none">(i) reciprocating saws(ii) rotary hand saws(iii) chain saws(b) Procedures for using air saws:<ul style="list-style-type: none">(i) underwater(ii) underground(iii) hazardous atmosphere(c) Method of cutting timber square and true(d) Methods of cutting timber:<ul style="list-style-type: none">(i) parallel to grain(ii) right angles to grain(iii) beavertail sawing(e) Importance of having blades or chains sharp(f) Care and maintenance of air saws(g) Importance of adequate air supply(h) Importance of correct lubrication(i) Science:<ul style="list-style-type: none">(i) properties of air |
| 9. Selecting and using pneumatic rivet passers | <ul style="list-style-type: none">(a) Types, features and use of rivet passers(b) Importance of correct air supply(c) Importance of maintaining passing hose in good condition(d) Hazards in improper use of rivet passers(e) Necessity of adequate eye protection(f) Science:<ul style="list-style-type: none">(i) properties of air |

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 2: Trade Tools and
Procedures

UNIT 4: Portable Electric Tools

OPERATIONS

KNOWLEDGE

- | | |
|---|--|
| 1. Selecting and using portable electric drills | (a) Types and features of electric drills:
(i) high speed
(ii) heavy duty
(iii) masonry
(b) Procedures for drilling using electric drills
(c) Method of grounding electric drills
(d) Techniques for minimizing line losses
(e) Care and maintenance of electric drills
(f) Science:
(i) work, energy, power
(ii) elementary circuitry |
| 2. Selecting and using portable electric grinders | (a) Types of electric grinders:
(i) high speed
(ii) intermediate speed
(b) Procedures for grinding using electric grinders
(c) Importance of grounding electric grinders
(d) Techniques for reduction of line losses in field application
(e) Science:
(i) work, energy, power
(ii) elementary circuitry |
| 3. Selecting and using electric impact wrenches | (a) Types, features and use of electric impact wrenches
(b) Limitations of use of electric impact wrench
(c) Method of maintaining machine at maximum efficiency
(d) Importance of grounding
(e) Care and maintenance of electric impact wrenches
(f) Science:
(i) work, energy, power
(ii) elementary circuitry |

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE
- GENERAL TRADE PRACTICE -

BLOCK 2: Trade Tools and
Procedures

UNIT 4: Portable Electric Tools

OPERATIONS	KNOWLEDGE
4. Selecting and using trepanning tools	(a) Types, features and use of trepanning tools (b) Purpose of trepanning (c) Use of coolants when trepanning
5. Selecting and using ventilating equipment	(a) Types, features and uses of ventilating equipment: (i) fans (ii) eductors (b) Methods of ventilating tanks, penstocks, pressure vessels
6. Selecting and using electric lumber saws	(a) Types, features and use of portable electric lumber saws: (i) rotary handsaw (ii) oscillating handsaw (b) Procedures for using electric lumber saws (c) Hazards in improper use of electric handsaws (d) Importance of eye protection when using electric saws (e) Importance of grounding electric saws (f) Selection of blades for electric saws

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 2: Trade Tools and
Procedures

UNIT 5: Miscellaneous Tools and Procedures

OPERATIONS

KNOWLEDGE

- | | |
|--|--|
| 1. Selecting and using portable high mechanical advantage machines | (a) Types, characteristics and use of mechanical advantage equipment <ul style="list-style-type: none">(i) chain blocks(ii) come-alongs(iii) tirfor jacks(iv) push-pull jacks |
| | (b) Procedures for using mechanical advantage equipment |
| | (c) Results of overstressing mechanical advantage equipment |
| | (d) Science: <ul style="list-style-type: none">(i) mechanical advantage of simple machines(ii) worm and wheel |
| | |
| 2. Selecting and using forges | (a) Types, features and use of portable and stationary forges: <ul style="list-style-type: none">(i) oil(ii) gas(iii) coal(iv) coke |
| | (b) Importance of air supply to forges <ul style="list-style-type: none">(i) power operated fans(ii) hand operated fans(iii) air jet |
| | (c) Types and features of tuyeres |
| | (d) Results of overheating in forges |
| | (e) Importance of eye protection |
| | (f) Methods of minimizing fire hazards |

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 2: Trade Tools and
Procedures

UNIT 5: Miscellaneous Tools and Procedures

OPERATIONS	KNOWLEDGE
3. Selecting and using heating torches	(a) Types, features and uses of heating torches: (i) oxy-propane (ii) oxy-acetylene (iii) oxy-hydrogen (iv) oxy-natural gas (b) Types and features of regulators (c) Types and features of tips (d) Procedures for setting up and regulating heating torches (e) Techniques in heating and shrinking (f) Techniques for determining temperature using: (i) tempilstik (ii) pyrometer (g) Hazards in improper use of heating torches (h) Science: (i) temperature indicators and scales (ii) heat transfer
4. Selecting and using pumps	(a) Types, features and use of electric and gasoline powered pumps: (i) centrifugal (ii) diaphragm (iii) reciprocating (iv) jet (b) Limiting lifts for pumps (c) Importance of tight fittings on pump (d) Foot valves and checks (e) Importance of proper lubrication of pumps (f) Science: (i) Pascals principle (ii) elementary hydraulics

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE
- GENERAL TRADE PRACTICE -

BLOCK 3: Rope and Tackle

TABLE OF CONTENTS

UNIT 1. Ropes	Page 28
2. Sheave Blocks	30

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 3: Rope and Tackle

UNIT 1: Ropes

OPERATIONS

KNOWLEDGE

1. Selecting rope

- (a) Interpretation of engineers instruction, shipping bills and relevant handbook to determine:
 - (i) load
 - (ii) height of lift
- (b) Evaluation and consideration of:
 - (i) size of hoist drum
 - (ii) sheave
- (c) Types, purposes and characteristic of:
 - (i) wire
 - (ii) manilla
 - (iii) nylon
 - (iv) hemp
 - (v) other
- (d) Results of using worn or incorrect size or type of rope
- (e) Importance and consideration of service conditions in selection of ropes
- (f) Method of ordering specifying rope
- (g) Mathematics:
 - (i) linear measurement to calculate length requirements
 - (ii) formula to calculate lead line pull and sheave size
 - (iii) formula to compute safe working load of wire rope
 - (iv) formula to calculate capacity of hoist drum
- (h) Science:
 - (i) strength of materials
 - (ii) stresses - tensile compression shear
 - (iii) atmospheric corrosion
 - (iv) nature of friction
 - (v) factor of safety

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 3: Rope and Tackle

UNIT 1: Ropes

OPERATIONS	KNOWLEDGE
2. Installing rope	<ul style="list-style-type: none">(a) Importance of visual inspection of rope for defects before installation(b) Method of reeving and installing rope:<ul style="list-style-type: none">(i) number of parts(ii) capacity(c) Nomenclature and construction features of rope fittings:<ul style="list-style-type: none">(i) clips and thimbles(ii) shackles(iii) turnbuckles(iv) swivels(v) hoist hooks(vi) corner softeners(d) Method of attaching fittings to rope(e) Importance of correct size of fittings(f) Effects of improper installation:<ul style="list-style-type: none">(i) abrasion(ii) alignment(iii) kinking(g) Types, purpose and characteristics of knots and splices(h) Techniques of making splices and knots(i) Effects of incorrect splices and knots(j) Types, purpose and characteristics of slings:<ul style="list-style-type: none">(i) chokers(ii) spreaders(iii) basket(iv) endless(v) chain(k) Correct use and application of sling(l) Importance of maintenance, care and storage of ropes - fittings - slings(m) Importance of checking installation before use(n) Mathematics:<ul style="list-style-type: none">(i) linear measurement to calculate length of rope(ii) formula to compute safe working load of wire rope(o) Science:<ul style="list-style-type: none">(i) nature of friction(ii) factor of safety(iii) strength of materials

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 3: Rope and Tackle

UNIT 2: Sheave Blocks

OPERATIONS

KNOWLEDGE

1. Selecting sheave blocks

- (a) interpretation of engineers' instructions, shipping bills and relevant handbook to determine:
 - (i) load
 - (ii) height of lift
- (b) Capacities and size of wire rope
- (c) Considerations and determination of number of parts in a tackle:
 - (i) rope
 - (ii) blocks
 - (iii) lead line pull
 - (iv) hoist drum capacity
- (d) Types, purpose and characteristics of blocks
 - (i) single sheave
 - (ii) multiple sheave
 - (iii) snatch block
- (e) Considerations of speed and load on sheaves:
 - (i) sheave diameter
 - (ii) groove size
 - (iii) type of bearing
- (f) Nomenclature and construction features of block components
- (g) Mathematics:
 - (i) calculation of area volume and weight, to determine load
 - (ii) formula to calculate capacity of hoist drum
 - (iii) formula to calculate safe working load of wire rope
 - (iv) formula to calculate load line pull
 - (v) linear measurement to calculate length of wire rope
- (h) Science:
 - (i) strength of materials
 - (ii) work - energy - power
 - (iii) nature of friction
 - (iv) sheave blocks
 - (v) factor of safety

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 3: Rope and Tackle

UNIT 2: Sheave Blocks

OPERATIONS

KNOWLEDGE

2. Installing sheave blocks

- (a) Importance of visual examination of equipment for defects before use
- (b) Procedures for checking tackle for physical defects
- (c) Method of reeving and installing tackle
- (d) Methods of servicing and maintaining sheave blocks
- (e) Effects of improper installation:
 - (i) fleet angle
 - (ii) reverse bends
 - (iii) alignment
- (f) Importance of seeking engineering or supervisor advice before installing tackle on structure
- (g) Effects of environmental conditions on tackle installation:
 - (i) pick-up of welding current in rope
 - (ii) formation of corrosive acid on wire rope
 - (iii) welding operation
- (h) Importance of checking installation for correct function before operating
- (i) Importance of barricades to protect load line
- (j) Mathematics: linear measuring devices to measure sheave grooves or wire rope diameter
- (k) Science:
 - (i) work - energy - power
 - (ii) nature of friction
 - (iii) sheave blocks
 - (iv) factor of safety
 - (v) lubricants and their uses

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 4: Scaffolds and Falsework

TABLE OF CONTENTS

UNIT 1. Hanging Scaffolds and Swing Stagings	Page 32
2. Rigid Scaffolds and Walkways	37
3. Movable and Powered Scaffolds	39
4. Ladders and Stairways	41
5. Barricades and Security	44
6. Personal Safety Equipment	45
7. Falsework	46
8. Timberwork	53

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 4: Scaffolds and Falsework UNIT 1: Hanging Scaffolds and Swing Stagings

OPERATIONS	KNOWLEDGE
1. Selecting a hanging scaffold	<ul style="list-style-type: none">(a) Interpretation of drawings, and examination of structure, to determine access required(b) Interpretation of Workmen's Compensation Board and Company standards and regulations(c) Types, characteristics and purposes of hanging scaffolds:<ul style="list-style-type: none">(i) needle beam and plank(ii) floats, plywood or nailed plank(iii) Bosun's chair(iv) powered spider buckets(v) painters' scaffolds(vi) suspended catwalk (for main cables of suspension bridge)(vii) other types(d) Nomenclature, functions and features of hanging scaffolds(e) Considerations when selecting a hanging scaffold:<ul style="list-style-type: none">(i) environment(ii) type of structure to be scaffolded(iii) load to be carried(iv) size of job to be scaffolded(f) Types and characteristics of points of support for hanging scaffolds:<ul style="list-style-type: none">(i) chokers round structure(ii) parapet hooks(iii) welded lugs or clips(iv) bolted lugs or clips(v) S hooks(vi) other supports(g) Need for supervising or engineering advice in choice of point of support(h) Types and characteristics of attachments of hanging scaffolds to points of support:<ul style="list-style-type: none">(i) knots, bends and eye splices(ii) wire rope clips(iii) sockets(iv) shackles(v) turnbuckles(vi) other connections

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 4: Scaffolds and Falsework UNIT 1: Hanging Scaffolds and Swing Stagings

OPERATIONS

KNOWLEDGE

1. Selecting a hanging
scaffold (cont'd)

- (j) Types, purpose and characteristics of arrangements for hanging scaffolds using:
 - (i) scaffold lines
 - (ii) manila falls
 - (iii) wire rope slings
 - (iv) hand powered hoists and ropes
 - (v) motor powered hoists and ropes
 - (vi) other devices
- (k) Procedure for testing scaffold plank
- (l) Characteristics of chain link fencing when used as deck for a suspended scaffold
- (m) Species and characteristics of lumber and plywood suitable for scaffolding
- (n) Types, characteristics and uses of ropes:
 - (i) manila
 - (ii) sisal
 - (iii) nylon
 - (iv) other fibres
 - (v) wire ropes
- (o) Type and application and considerations in the use of:
 - (i) safety nets
 - (ii) safety lines
 - (iii) other safety equipment
- (p) Importance of providing adequate access and scaffolding on a job
- (q) Mathematics:
 - (i) linear measurement, for lengths of ropes
 - (ii) formula for length of rope on a drum
 - (iii) calculation of loads on scaffolds
- (r) Science:
 - (i) fireproofing of wood
 - (ii) wood preservation
 - (iii) seasoning of wood
 - (iv) reactions at supports
 - (v) pulley blocks (rope falls)
 - (vi) stresses - tensile, compressive, shear

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 4: Scaffolds and Falsework UNIT 1: Hanging Scaffolds and Swing Stagings

OPERATIONS	KNOWLEDGE
2. Hanging a scaffold	<ul style="list-style-type: none">(a) Interpretation of drawings and examination of structure to identify points of support(b) Need for engineering or supervisory advice on points of support(c) Method of building hanging scaffold decks:<ul style="list-style-type: none">(i) standard types(ii) preparation of sketch and material bill(iii) cut lumber to size(iv) timber joints, nailed and/or bolted(d) Types, characteristics and uses of wire ropes in scaffolds:<ul style="list-style-type: none">(i) rope constructions(ii) black ropes(iii) galvanised ropes(iv) other wire ropes(e) Methods of rigging hanging scaffolds(f) Importance of tying off running end of scaffold hoisting tackles to the scaffold only(g) Importance of toe boards on scaffolds(h) Purpose and importance of cleats on scaffold planks(i) Importance of avoiding overhang on scaffold planks(j) Value of softeners and thimbles in preventing damage to ropes on sharp corners(k) Method of erecting suspended catwalk for main cables of suspension bridge(l) Need for independent inspection of field welds on support lugs(m) Importance of installing safety lines round hanging scaffolds(n) Methods of care and handling for scaffold plank(o) Importance and procedures for levelling scaffolds(p) Recommended details for field fabricated scaffolds and floats

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 4: Scaffolds and Falsework UNIT 1: Hanging Scaffolds and Swing Stagings

OPERATIONS

KNOWLEDGE

2. Hanging a scaffold
(cont'd)

- (q) Consideration of the effects of service conditions on ropes:
 - (i) dampness
 - (ii) industrial chemicals
 - (iii) sharp edges
 - (iv) kinks
 - (v) fire, sparks, welding and burning
 - (vi) fraying due to unwhipped ends
 - (vii) other hazards
- (r) Importance of limiting load on scaffold
- (s) Need for independent inspection of welds on clips, lugs, brackets
- (t) Importance and method of inspection of structural condition of scaffold parts
- (u) Types, characteristics and uses of lumber available for scaffolds
- (v) Methods and importance of testing scaffold planks
- (w) Maintenance and storage of scaffolding material after use
- (x) Mathematics:
 - (i) weights and measures to calculate weights
 - (ii) linear measurement to compute line lengths
- (y) Science:
 - (i) wood decay and preservation
 - (ii) seasoning of wood
 - (iii) reactions at supports
 - (iv) stresses, tensile, compressive, shear
 - (v) ropes and rope blocks in tackles
 - (vi) stresses in loaded, inclined suspended wire ropes
 - (vii) strength of nailed or bolted timber joints

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 4: Scaffolds and Falsework UNIT 1: Hanging Scaffolds and Swing Stagings

OPERATIONS	KNOWLEDGE
<hr/>	
3. Maintaining Hanging Scaffold	<ul style="list-style-type: none">(a) Importance of limiting loads on scaffolds(b) Methods of moving hanging scaffolds(c) Value of periodic inspection of the complete hanging scaffold system(d) Methods of servicing and maintaining scaffold components(e) Need for regular maintenance of moving parts(f) Methods of tying off the scaffold after moving, and at the end of the day(g) Effects to be expected from misuse of a hanging scaffold(h) Results of heat or damp on scaffold lines and planks(i) Methods of maintaining and storing scaffold material after use(j) Mathematics:<ul style="list-style-type: none">(i) weights and measures to calculate loads on scaffolds(k) Science:<ul style="list-style-type: none">(i) pulley blocks and rope tackles

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 4: Scaffolds and Falsework UNIT 2: Rigid Scaffolds and Walkways

OPERATIONS

KNOWLEDGE

1. Selecting a rigid
scaffold or walkway

- (a) Interpretation of drawings and examination of structure to determine access required
- (b) Interpretation of Workmen's Compensation Board and Company standards and regulations
- (c) Types, purposes and characteristics of rigid scaffold and walkway supports:
 - (i) steel beams in buildings or bridge decks
 - (ii) steel brackets for platework, fixed and adjustable
 - (iii) steel brackets for bridgework
 - (iv) standard gauge service track on bridges
 - (v) tubular scaffolding
 - (vi) prefabricated steel frame scaffolding
 - (vii) temporary steel trusses
 - (viii) saw horses and trestles
 - (ix) other supports
- (d) Nomenclature, functions and features of rigid scaffolds and walkways
- (e) Types, purposes and characteristics of materials for decking rigid scaffolds:
 - (i) plank and plywood
 - (ii) other contractors' materials on site; steel decking or formwork
- (f) Types and characteristics of attachments for rigid scaffolds and walkways:
 - (i) bolts in holes
 - (ii) hook bolts
 - (iii) cleats on planks or stringers
 - (iv) hooks in welded clips
 - (v) tapered pins in welded clips
 - (vi) other attachments
- (g) Consideration when selecting a rigid scaffold
- (h) Interpretation of Manufacturers' handbooks and catalogues on standard scaffolding
- (i) Types, characteristics and uses of lumber and plywood used for decking scaffolds:
 - (i) lumber species
 - (ii) lumber grades and defects
 - (iii) plywood grades and defects
- (j) Mathematics: weights and measures to calculate loads on the scaffold

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 4: Scaffolds and Falsework UNIT 2: Rigid Scaffolds and Walkways

OPERATIONS	KNOWLEDGE
1. Selecting a rigid scaffold or walkway (cont'd)	(k) Science: <ul style="list-style-type: none">(i) fireproofing of wood(ii) wood preservation(iii) seasoning of wood(iv) reactions at supports(v) stresses - tensile, compressive, shear(vi) classification and identification of steel
2. Installing and maintaining rigid scaffold or walkway	<ul style="list-style-type: none">(a) Site examination of ground or structure for available supports or interference(b) Nomenclature, function and erection features of:<ul style="list-style-type: none">(i) prefabricated framed steel scaffolding(ii) tubular steel scaffolding(c) Method of erecting rigid scaffolds and walkways(d) Procedures for erection of attachments and supporting structure(e) Methods of attaching plank or plywood to structures to prevent movement due to:<ul style="list-style-type: none">(i) traffic(ii) wind(f) Importance of avoiding hazard from overhanging plank(g) Consideration and value of handrails, kickboards, toe plates(h) Importance of the care and handling of the plank(i) Importance and method of inspecting and testing structural parts of rigid scaffolds and walkways(j) Need for periodic inspection of condition of scaffold material(k) Importance of effects of storage and handling on condition of scaffold material(l) Science:<ul style="list-style-type: none">(i) stresses in rope lashings(ii) preservation of wood(iii) seasoning of wood plank

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 4: Scaffolds and Falsework UNIT 3: Movable and Powered Scaffolds

OPERATIONS

KNOWLEDGE

1. Selecting a movable or
powered scaffold

- (a) Interpretation of drawings and examination of site and structure to determine access required
- (b) Interpretation of Workmen's Compensation Board and Company standards and regulations
- (c) Use of manufacturers' handbooks and catalogues to determine scaffold specifications
- (d) Types, purposes and characteristics of movable and powered scaffolds:
 - (i) temporary truss bridges on monorails
 - (ii) wheel mounted scaffolds
 - (iii) truck mounted scaffolds
 - (iv) giraffes and other movable buckets
 - (v) other types
- (e) Nomenclature, function and features of movable scaffold parts
- (f) Considerations in the selection of movable or powered scaffolds
- (g) Mathematics: weights and measures to calculate loads on the scaffold
- (h) Science:
 - (i) stresses in pulley systems (rope falls or tackle)
 - (ii) work, power, energy
 - (iii) reactions at supports
 - (iv) stresses in simple beams or trusses
 - (v) stresses - tensile, compressive, shear
 - (vi) hydraulic jacks and fluid pressures
 - (vii) force pumps
 - (viii) levers
 - (ix) mechanical advantages of simple machines

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 4: Scaffolds and Falsework UNIT 3: Movable and Powered Scaffolds

OPERATIONS	KNOWLEDGE
<hr/>	
2. Installing and maintaining movable or powered scaffold	<ul style="list-style-type: none">(a) Nomenclature, function and erection features of movable or powered scaffold components(b) Methods of assembly of movable or powered scaffolds(c) Importance and procedure for fixing scaffolds between movements(d) Value of periodic inspections of scaffolds(e) Importance of periodic maintenance of moving parts(f) Consideration when using a movable or powered scaffold(g) Procedures for servicing and maintaining movable and powered scaffolds(h) Effects of overloads on movable and powered scaffolds(i) Care and storage of scaffold equipment(j) Science:<ul style="list-style-type: none">(i) types of lubricants and their uses(ii) lubricant deterioration

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 4: Scaffolds and Falsework UNIT 4: Ladders and Stairways

OPERATIONS	KNOWLEDGE
1. Selecting a ladder or stairway	<ul style="list-style-type: none">(a) Interpretation of drawings and examination of structure to determine access required(b) Interpretation of Workmen's Compensation Board and Company standards and regulations(c) Types, purposes and characteristics of ladders and stairways:<ul style="list-style-type: none">(i) rope ladders; wire, nylon, manila(ii) rigid ladders; wood, steel, aluminum(iii) extension ladders; wood, steel, aluminum(iv) step ladders; wood, steel, aluminum(v) landings(vi) temporary stairways(vii) stairway sections in prefabricated steel frame scaffolding(viii) other ladders and stairways(d) Nomenclature, function and features of ladder and stairway parts(e) Factors affecting the selection of ladder or stairways:<ul style="list-style-type: none">(i) vertical loads(ii) lateral movement(iii) ladder rung spacing and toe clearance(iv) rise and tread of stairways(f) Considerations when selecting a ladder or stairway(g) Considerations in the use of safety cages, handrails and landings on long runs of ladders and stairways(h) Types and application of supporting feet of ladders:<ul style="list-style-type: none">(i) plain(ii) non skid rubber pivotted feet(iii) spiked feet(iv) other feet(i) Mathematics:<ul style="list-style-type: none">(i) linear measurement to layout of rise and tread(ii) Pythagoras theorem to calculate rise, tread and stringer(j) Science:<ul style="list-style-type: none">(i) ferrous and non-ferrous metals (used for ladders and stairways)(ii) stresses - tensile, compressive, shear(iii) properties, grades and species of lumber

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 4: Scaffolds and Falsework UNIT 4: Ladders and Stairways

OPERATIONS

KNOWLEDGE

2. Erecting a ladder or stairway

- (a) Procedures for examination of site to determine access required
- (b) Methods of supporting feet of ladders
 - (i) plain
 - (ii) nonskid rubber pivotted feet
 - (iii) spiked feet
 - (iv) other feet
- (c) Procedures for moving ladders:
 - (i) in the horizontal position
 - (ii) in the vertical position
- (d) Techniques of raising long ladders
 - (i) straight
 - (ii) extension
- (e) Importance and method of supporting ladders on:
 - (i) soft ground
 - (ii) uneven ground
- (f) Methods of supporting heads of ladders for vertical loads or from lateral movement:
 - (i) tie head to structure
 - (ii) hooks or knots for hanging ladders
 - (iii) other methods
- (g) Importance of independent inspection of welds on ladder lugs and clips
- (h) Importance of toe clearance behind rungs of hanging ladder
- (i) Recommended slopes of ladders and stairways
- (j) Importance of ladder rails to project above landings
- (k) Procedures and requirements for field fabrication of ladders and stairways:
 - (i) wood
 - (ii) steel
- (l) Importance of anchoring bottom of a rope ladder
- (m) Hazards of using ladders on slopes
- (n) Importance of levelling ladder on stairway before use
- (o) Mathematics:
 - (i) Pythagoras theorem to calculate rise, slope and tread
 - (ii) formulae to calculate length of stairway or ladder required for a given height

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 4: Scaffolds and Falsework

UNIT 4: Ladders and Stairways

OPERATIONS

KNOWLEDGE

2. Erecting a ladder or
stairway (cont'd)

- (p) Science:
- (i) stresses - tensile, compressive, shear
 - (ii) properties, grades and species of
lumber used for ladders and stairways
 - (iii) properties of ferrous and non ferrous
metals
 - (iv) seasoning of wood
 - (v) preservation of wood

3. Using and maintaining
ladders and stairways

- (a) Factors limiting the use of ladders and
stairways
- (b) Limitations on loads on ladder rungs or
stair treads
- (c) Techniques of using ladders to cross gaps
- (d) Importance of steadying the foot of a long
ladder on a hard surface using:
 - (i) lashing
 - (ii) helper
- (e) Technique of using ladder jacks to support
scaffold planks
- (f) Need for periodic inspection of ladders and
stairway installations
- (g) Methods of denying access to a ladder or
stairway at end of shift:
 - (i) remove bottom section of ladder
 - (ii) padlocked gate
 - (iii) other techniques
- (h) Value of regular maintenance on ladders and
stairways
- (i) Recommended storage procedures for ladders
and pre-fabricated stairway sections

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 4: Scaffolds and Falsework UNIT 5: Barricades and Security

OPERATIONS

KNOWLEDGE

1. Maintaining security

- (a) Hazards to the public and workmen of other trades on structural steel and plate erection jobsites:
 - (i) falls, collisions and drowning
 - (ii) falling objects and flying particles
 - (iii) respiratory
 - (iv) electrical shock
 - (v) radiation exposure
 - (vi) welding flash
 - (vii) other
- (b) Importance of controlling movement of public and other workmen to:
 - (i) ensure security and condition of tools and equipment
 - (ii) prevent distraction of structural steel and plate erectors
- (c) Characteristics and use of hazard guarding devices:
 - (i) safety boats
 - (ii) safety nets
 - (iii) covered walkways
 - (iv) handrails
 - (v) stagings and scaffolds
 - (vi) hoardings and screens
 - (vii) barricades
 - (viii) other
- (d) Techniques for warning workmen and others of hazards:
 - (i) notices, signs
 - (ii) guards, watchmen, flagmen
 - (iii) sirens, horns, whistles, bells
 - (iv) warning lights
- (e) Importance of securing equipment and job access during job down time
- (f) Effects of poor job security
- (g) Importance of knowing location of security facilities:
 - (i) police
 - (ii) first aid
 - (iii) fire station
 - (iv) other
- (h) Value of prompt reporting of any incidents
- (i) Science:
 - (i) radiation (x-ray and flash)
 - (ii) conductors and insulators

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 4: Scaffolds and Falsework UNIT 6: Personal Safety Equipment

OPERATIONS

KNOWLEDGE

1. Selecting and using
personal safety equipment

- (a) Nature of personal hazards in structural steel and platework erection
 - (i) eye injuries; grit, chips
 - (ii) eye damage, welding flash
 - (iii) falls
 - (iv) drowning
 - (v) falling objects
 - (vi) electric shock
 - (vii) other
- (b) Interpretation of Workmen's Compensation Board and Company safety standards and regulations
- (c) Characteristics, applications, and methods of fitting and using personal protective equipment:
 - (i) goggles, safety glasses
 - (ii) welder's helmets, shields
 - (iii) safety belts and lines
 - (iv) life jackets (bouyant)
 - (v) hard hats and liners
 - (vi) hard toe boots
 - (vii) gloves
 - (viii) welder's aprons
 - (ix) other
- (d) Interpretation of suppliers catalogs, handbooks and specifications for personal safety equipment
- (e) Considerations when selecting personal safety equipment
- (f) Effects of failure to observe Company and Workmen's Compensation Board standards and regulations re personal safety equipment
- (g) Science:
 - (i) effects of welding flash
 - (ii) effects of deceleration and impact

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 4: Scaffolds and Falsework UNIT 7: Falsework

OPERATIONS	KNOWLEDGE
1. Installing falsework foundations	<ul style="list-style-type: none">(a) Interpretation of drawings and specifications to determine:<ul style="list-style-type: none">(i) type and capacity of foundations(ii) location(iii) site preparation requirements(b) Type, function and characteristics of foundations for falsework and shoring:<ul style="list-style-type: none">(i) mudsills and plank(ii) concrete slabs (plain or reinforced)(iii) cribs (empty or rock-filled)(iv) floating(v) ice(vi) rock(vii) gravel(viii) other(c) Evaluation of site and/or soil conditions to facilitate construction of foundations(d) Procedure for determining material quantities(e) Techniques of excavating and/or preparing foundation site(f) Method of laying out falsework foundations(g) Type, characteristics and construction of forms for falsework foundations(h) Techniques of placing, pouring reinforcing and/or constructing falsework foundations(i) Importance of sound construction practice in constructing falsework foundations(j) Procedure and importance of establishing bench marks and check points to assess movement of foundations under load(k) Mathematics:<ul style="list-style-type: none">(i) linear measurement to determine elevations(ii) weights to calculate foundation loads(iii) weights and linear measurement to compute material quantities(l) Science:<ul style="list-style-type: none">(i) stability of soils(ii) strength of materials(iii) properties of wood, steel and concrete

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 4: Scaffolds and Falsework UNIT 7: Falsework

OPERATIONS

KNOWLEDGE

2. Driving piles

- (a) Interpretation of drawings and specifications to determine:
 - (i) type of piles
 - (ii) location of pile foundations
 - (iii) site preparation requirements
- (b) Type, function and characteristics of friction and bearing piles:
 - (i) rolled steel section
 - (ii) timber (square and round)
 - (iii) steel pipe (empty, sand or concrete filled)
- (c) Evaluation of site and/or soil conditions to facilitate pile driving operations
- (d) Method of laying out pile and bent locations
- (e) Techniques of handling piles
- (f) Type, function and driving characteristic of pile driving hammers:
 - (i) drop
 - (ii) single or double acting (air or steam)
 - (iii) diesel
 - (iv) other types
- (g) Types, function and operating procedures of pile driving rigs:
 - (i) leads hung from crane boom
 - (ii) hammer hung from crane boom
 - (iii) floating
 - (iv) other
- (h) Procedures for driving piles
- (i) Techniques of bracing piles in bents:
 - (i) in air
 - (ii) under-water
- (j) Type, characteristics and construction of staging required when driving piles:
 - (i) spiked or welded to piles
 - (ii) floats of logs or timbers
- (k) Recognition of characteristics when piles are driven to refusal
- (l) Effects of underdriving as overdriving piles
- (m) Considerations in the driving of test piles to evaluate adequacy of falsework foundation
- (n) Techniques and characteristics of systems to test-load piles using:
 - (i) dead-weights
 - (ii) jacks or strongbacks
- (o) Effects of time on the 'setting up' of friction piles

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 4: Scaffolds and Falsework UNIT 7: Falsework

OPERATIONS	KNOWLEDGE
<hr/>	
2. Driving piles (cont'd)	<ul style="list-style-type: none">(p) Importance of seeking engineering advice in estimating the safe load on friction piles(q) Procedures for establishing and marking cut off elevation of piles:<ul style="list-style-type: none">(i) bench marks(ii) check points(r) Techniques of cutting off piles(s) Type, purpose and method of capping piles(t) Procedures for the removal and disposal of piles(u) Mathematics:<ul style="list-style-type: none">(i) linear measurement to layout pile locations(ii) linear measurement to determine pile elevation from bench marks and check points(iii) weights and measures to calculate displacement and local characteristics of piles(v) Science:<ul style="list-style-type: none">(i) work - energy - power(ii) momentum(iii) inertia(iv) acceleration and deceleration(v) properties of wood and steel(vi) wood preservation

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 4: Scaffold and Falsework UNIT 7: Falsework

OPERATIONS

KNOWLEDGE

3. Erecting falsework

- (a) Interpretation of drawings, specifications and engineering data to determine:
 - (i) falsework requirements
 - (ii) details of structure
 - (iii) location
 - (iv) site characteristics
 - (v) load and height requirements
- (b) Examination and evaluation of site for access and other limitations
- (c) Type, function and characteristics of falsework:
 - (i) struts - wood and steel
 - (ii) sawhorses
 - (iii) trestles
 - (iv) bents
 - (v) temporary or existing bridges
 - (vi) launching trusses
 - (vii) temporary tower, forestay and backstay systems
 - (viii) cable, eyebar and other tieback systems
 - (ix) temporary and permanent strengthening structures
 - (x) spiders - in penstock or vessel cans
 - (xi) floating equipment
 - (xii) air and water
 - (xiii) other
- (d) Type, characteristics and methods of bracing falsework:
 - (i) sway bracing
 - (ii) wind bracing
 - (iii) longitudinal bracing in trestles
 - (iv) diagphrams between beams
 - (v) stiffeners or plates or webs
 - (vi) guys
 - (vii) batter piles
 - (viii) kneebraces
 - (ix) hog lines
 - (x) cover plates
 - (xi) other
- (e) Type, functions and characteristics of falsework to structure connections:
 - (i) tension - bolts, pins, welded lugs
 - (ii) compression - kick blocks
 - (iii) shear - lugs and slots
 - (iv) other

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 4: Scaffolds and Falsework UNIT 7: Falsework

OPERATIONS	KNOWLEDGE
3. Erecting falsework (cont'd)	<ul style="list-style-type: none">(f) Type, function and characteristics of provisions for adjusting and/or releasing falsework:<ul style="list-style-type: none">(i) wedges - wood and steel(ii) jacks - screw, ratchet, hydraulic, sand(iii) flooding or pumping out(iv) toggling(v) other(g) Consideration of factors and conditions affecting the erection of falsework:<ul style="list-style-type: none">(i) climatic conditions(ii) traffic(iii) material availability(iv) other(h) Procedures for determining type and quantities of material specified for falsework construction(i) Methods of laying out and locating falsework on foundations(j) Techniques of framing falsework using:<ul style="list-style-type: none">(i) timber(ii) steel(iii) other(k) Type, purpose and use of tools used in framing falsework(l) Consideration and benefits of re-using and/or repetitive use of falsework materials(m) Methods of setting-up and bracing falsework(n) Procedures for aligning falsework(o) Importance and method of maintaining correct line and elevation for top of falsework(p) Permissible tolerances in line and level at top of falsework(q) Techniques for adjusting falsework(r) Importance of frequent checks on plumbness, line and level at top of falsework(s) Procedure for landing structure on the falsework using:<ul style="list-style-type: none">(i) wedges - fills - shims(ii) jacks - in the falsework(iii) jacks - in the structure(iv) other(t) Effects of compression and crushing on height of falsework

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 4: Scaffolds and Falsework UNIT 7: Falsework

OPERATIONS	KNOWLEDGE
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3. Erecting falsework (cont'd)	<ul style="list-style-type: none">(u) Procedures for measuring actual load on falsework(v) Importance of independent inspection of field connections in falsework:<ul style="list-style-type: none">(i) pinned(ii) bolted(iii) welded(w) Methods and importance of protecting falsework from damage(x) Importance of seeking engineering or supervisory advice(y) Mathematics:<ul style="list-style-type: none">(i) linear measurement to determine elevation and levels(ii) weights and measures to calculate load, pressure and volume(iii) formulae to calculate areas(z) Science:<ul style="list-style-type: none">(i) reaction at supports(ii) bending and shear stresses in beams(iii) capacity of columns(iv) stress and strain - tensile - compressive - shear(v) properties and strength of materials - steel - concrete - wood(vi) bolted - rivetted and welded joints(vii) factor of safety

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICES -

BLOCK 4: Scaffolds and Falsework UNIT 7: Falsework

OPERATIONS	KNOWLEDGE
4. Releasing falsework	<ul style="list-style-type: none">(a) Techniques and importance of checking permanent structure for completeness and alignment before releasing falsework(b) Procedures for release of falsework by jacking structure, using:<ul style="list-style-type: none">(i) lifting jacks - mechanical and hydraulic(ii) sand jacks(c) Considerations and procedures when swinging fully supported truss spans:<ul style="list-style-type: none">(i) lengthening of bottom chord(ii) shortening of top chord(d) Procedures for release of load wedges:<ul style="list-style-type: none">(i) timber(ii) steel(e) Techniques for drilling or cutting away legs to release falsework:<ul style="list-style-type: none">(i) timber(ii) steel(f) Emergency procedures for releasing falsework in case of sudden flood or other conditions(g) Factors affecting the disposal of falsework:<ul style="list-style-type: none">(i) re-use(ii) repetition(h) Science:<ul style="list-style-type: none">(i) preparation, properties, storage and uses of gases, e.g. acetylene and oxygen(ii) classification of steels(iii) effect of heat on construction steels

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 4: Scaffolds and Falsework UNIT 8: Timberwork

OPERATIONS	KNOWLEDGE
1. Framing timber structures	<ul style="list-style-type: none">(a) Interpretation of drawings and specifications to determine timberwork requirements:<ul style="list-style-type: none">(i) height, length and width of structure(ii) loading(iii) location(b) Examination and evaluation of site for access and other limitations(c) Type, function and characteristics of common timber structures:<ul style="list-style-type: none">(i) cribs(ii) posts, shores, struts, legs and columns(iii) bents - piled and framed(iv) mudsills and grillages(v) bridge ties and guardrails(vi) scaffolds and staging(d) Terminology and identification of parts of timber structures(e) Type, purpose and characteristics of the elements of timber structures:<ul style="list-style-type: none">(i) beams(ii) posts(iii) braces(iv) whalers and collars(v) daps and notches(vi) sills(f) Type, and structural design characteristic of Canadian timber:<ul style="list-style-type: none">(i) Douglas fir(ii) Spruce(iii) Hemlock(iv) Cedar(v) other(g) Factor in the selection of wood for timber structures(h) Type, function and strength characteristics of common timber fasteners:<ul style="list-style-type: none">(i) bolts and washers(ii) drift bolts(iii) nails(iv) spikes(v) timber dogs(vi) ring shear connective(vii) spike grid shear connective(viii) rope lashings - manilla or wire(ix) other

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 4: Scaffolds and Falsework UNIT 8: Timberwork

OPERATIONS	KNOWLEDGE
1. Framing timber structures (cont'd)	<ul style="list-style-type: none">(i) Procedure for determining material quantities(j) Techniques and factors to be considered when marking and laying out timber framing(k) Effects of poor layout on the final structure(l) Type, purpose and use of tools used for fabricating structural elements(m) Method and importance of sawing timbers square and true(n) Techniques of splicing timbers and piles(o) Application and methods of cutting daps and hatches(p) Effect of shrinkage and crushing on length of structural timbers(q) Methods of calculating allowances for shrinkage and crushing(r) Techniques of fastening and assembling timber structures(s) Effects of inadequate fastening of the elements of timber structures(t) Effect resulting from nailing or bolting near the edge or end of a timber(u) Importance and effect of using washers under head and nut of bolts(v) Methods of plumbing and aligning structure during and at completion of assembly(w) Mathematics:<ul style="list-style-type: none">(i) linear measurement for laying and marking out(ii) angular measurement for layout(iii) Pythagoras theorem to calculate and layout structural markers(iv) weights and measures to calculate load or structure(v) formulae to calculate shrinkage and crushing allowances(vi) volume to calculate displacement of timber(vii) linear measurement to calculate length of fastenings(viii) formulae to calculate strength of fasteners

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE

BLOCK 4: Scaffolds and Falsework UNIT 8: Timberwork

OPERATIONS

KNOWLEDGE

1. Framing timber structures
(cont'd)

(x) Science:

- (i) strength of materials - timber and fasteners
- (ii) chemical composition of wood
- (iii) fireproofing of wood
- (iv) wood preservation
- (v) seasoning of wood
- (vi) galvanic corrosion (fasteners)
- (vii) simple frames

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 4: Scaffold and Falsework UNIT 8: Timberwork

OPERATIONS	KNOWLEDGE
2. Slinging and handling timber structures	<ul style="list-style-type: none">(a) Type, function and characteristics of equipment used for lifting structures(b) Type, purpose and use of slings(c) Methods of slinging and lifting timber structures(d) Importance of using softeners under slings to protect edges and corners of timbers(e) Factors to be considered when lifting timber structures(f) Effects of lifting on wrong part of structure(g) Considerations in locating and placing structures:<ul style="list-style-type: none">(i) access(ii) matchmarking(iii) repetition(iv) re-use(h) Procedures for locating and placing timber structures(i) Methods of aligning and plumbing structure after placement and locating(j) Mathematics:<ul style="list-style-type: none">(i) weights and measures to calculate weight of structure(ii) linear measurement to determine location and placement(k) Science:<ul style="list-style-type: none">(i) strength of materials (slings, wire and manilla rope)(ii) work - energy - power

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE
- GENERAL TRADE PRACTICE -

BLOCK 5: Erection Equipment

TABLE OF CONTENTS

UNIT 1: Cranes	Page 58
2: Derricks	65
3: Hoists and Winches	73
4: Jacks	78
5: Equipment for Heavy Moving	83
6: Other Erection Equipment	87

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 5: Erection Equipment

UNIT 1: Cranes

OPERATIONS

KNOWLEDGE

1. Selecting cranes

- (a) Interpretation of drawings, specifications and Manufacturers capacity charts to determine:
 - (i) nature of job
 - (ii) crane capacities
- (b) Effect of site conditions on crane selection:
 - (i) ground capacity
 - (ii) access
 - (iii) obstructions - ditches, wires, buildings
- (c) Types, purposes, characteristics and size ranges of cranes:
 - (i) crawler
 - (ii) truck, and self-propelled truck
 - (iii) rail, locomotive
 - (iv) bullmoose
 - (v) hydraulic
 - (vi) fork lift
 - (vii) straddle carrier
 - (viii) level luffing
 - (ix) gantry and semi gantry
 - (x) tower
 - (xi) revolver/whirley
 - (xii) overhead travelling
 - (xiii) sideboom tractor
 - (xiv) hammerhead
 - (xv) other
- (d) Nomenclature, function and features of cranes and crane components
- (e) Considerations in selecting cranes:
 - (i) power assists
 - (ii) boom and jib details
 - (iii) mobility - truck and crawler mounting
- (f) Importance of mechanical and structural condition of cranes
- (g) Importance of obtaining engineering assistance in the selection of cranes for unusual conditions
- (h) Procedures for determining required boom lengths and counterweight clearances
- (i) Techniques for computing weights using bills, drawings and handbooks

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 5: Erection Equipment

UNIT 1: Cranes

OPERATIONS

KNOWLEDGE

1. Selecting cranes (cont'd)

(j) Mathematics:

(i) linear measurement to determine length of booms and operating lines

(ii) Pythagorean theorem to compute required length of boom

(k) Science:

(i) levers

(ii) strength of columns and struts

(iii) brake and indicated horsepower

(iv) wheel and axle

(v) screw jack

(vi) pulley blocks (load and boom falls)

(vii) gear drives

(viii) chain drives

(ix) work, energy, power

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 5: Erection Equipment

UNIT 1: Cranes

OPERATIONS

KNOWLEDGE

2. Loading, moving and
receiving a crane

- (a) Interpretation of regulations governing movement of cranes by:
 - (i) road
 - (ii) rail
 - (iii) water
- (b) Limitations on movement due to:
 - (i) height
 - (ii) width
 - (iii) length
 - (iv) weight
- (c) Importance of adequate ramps and platforms
- (d) Procedures for stripping cranes ready for moving
- (e) Importance of loading pennants in corresponding boom sections
- (f) Methods of loading a crane for transportation by:
 - (i) road
 - (ii) rail
 - (iii) water
- (g) Considerations and techniques when blocking and tying down a crane for shipment
- (h) Types, characteristics and capacities of wire rope lashings
- (i) Special considerations when loading barges and scows:
 - (i) tide
 - (ii) wind
 - (iii) wharfage
 - (iv) scow grids
 - (v) beachings and groundings
- (j) Importance of care when handling a crane
- (k) Procedures for storing and shipping dismantled parts of a crane
- (l) Hazards of removing boom from a crane with full counterweight
- (m) Importance of care when descending long hills with truck cranes
- (n) Considerations and procedures for reassembly of crane at destination
- (o) Results of inadequate blocking and tying down of a crane shipment:
 - (i) rejected by carrier
 - (ii) damage to crane
 - (iii) damage to other traffic
- (p) Mathematics: Linear measurement to determine length of tiedowns and lashings

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE
- GENERAL TRADE PRACTICE -

BLOCK 5: Erection Equipment

UNIT 1: Cranes

OPERATIONS

KNOWLEDGE

3. Setting up crane for work

- (a) Interpretation of drawings and site conditions to determine:
 - (i) access for crane and steel
 - (ii) sequence of erection
 - (iii) ground capacity
 - (iv) obstructions
 - (v) overhead electric wires
 - (vi) requirements of other contractors
 - (vii) locations for fewest moves of crane
 - (viii) other
- (b) Interpretation of Workmen's Compensation Board and Company standards and regulations
- (c) Procedure for offloading and reassembly of crane
- (d) Methods of lengthening or shortening crane boom
- (e) Techniques for installation and alignment of jib on crane boom
- (f) Procedures for raising long crane booms
- (g) Importance of use of mats and pads on poor ground
- (h) Use and benefits of outriggers on truck cranes
- (j) Procedures for setting up outriggers and blocking on truck cranes:
 - (i) manual
 - (ii) power
- (k) Need for adequate area under outrigger blocking
- (l) Considerations when using cranes on barges or other floating equipment
- (m) Application and use of deck hoists on barges used for crane mountings
- (n) Value of test lifts on cranes
- (o) Procedure for making a test lift on a crane
- (p) Interpretation of crane manufacturers capacity charts
- (q) Methods and value of electrically grounding a crane when working near a power line

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE
- GENERAL TRADE PRACTICE -

BLOCK 5: Erection Equipment

UNIT 1: Cranes

OPERATIONS

KNOWLEDGE

3. Setting up crane for work
(cont'd)

- (r) Results of improper crane set-up:
 - (i) lack of drift
 - (ii) collapse of excessive boom
 - (iii) subsistence
 - (iv) overturning
 - (v) rear instability, due to excessive counterweight
 - (vi) apparent extra capacity, due to excessive counterweight
 - (vii) crane base not level, leading to excessive lateral forces on the boom
- (s) Consideration of ground conditions and their effect on the stability of cranes
- (t) Characteristics of ice and frozen or thawing ground
- (u) Hazards and importance of care when operating cranes near high tension lines.

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 5: Erection Equipment

UNIT 1: Cranes

OPERATIONS

KNOWLEDGE

4. Lifting with crane

- (a) Examination of drawings and shipping advices for:
 - (i) detailed sequence of erection
 - (ii) shipping/erection marks
- (b) Interpretation of Workmen's Compensation Board and Company standards and regulations
- (c) Procedures when lifting with crane
- (d) Importance of organizing and coordinating the work of the:
 - (i) hooker-on
 - (ii) signalman
 - (iii) connector
 - (iv) crane operator (hoisting engineer)
- (e) Application of signals when using crane:
 - (i) hand signals
 - (ii) sound signals - horn or bell
- (f) Considerations when lifting with crane
- (g) Interpretation of crane manufacturers capacity charts and manuals
- (h) Importance and techniques for using a tag-line on the load
- (i) Effect of improper crane operation:
 - (i) overturning due to excessive radius or load
 - (ii) boom collapse due to excessive slewing acceleration or deceleration
 - (iii) impact forces from erratic lifting or lowering speeds
 - (iv) excessive radius due to excessive slewing speeds
- (j) Hazards to a man working near crane counter-weight
- (k) Hazards of standing under the load or crane boom
- (l) Hazards of contact with overhead electric wires
- (m) Procedures for moving with long boom on crane
- (n) Occasions when man may ride crane hook
- (o) Principles and techniques for dividing a long or heavy load between two or more cranes
- (p) Importance of making crane safe at the end of a shift
- (q) Servicing and minor maintenance of cranes
- (r) Importance of periodic inspection of cranes and lifting gear

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 5: Erection Equipment

UNIT 1: Cranes

OPERATIONS

KNOWLEDGE

4. Lifting with crane
(cont'd)

- (s) Mathematics: Ratio and proportion to determine weights and lifting speeds
- (t) Science:
 - (i) nature of electric shock
 - (ii) types of lubricants and their uses
 - (iii) viscosity ratings of lubricants
 - (iv) lubricant deterioration
 - (v) types, uses and action of fire extinguishers
 - (vi) acceleration/deceleration
 - (vii) centrifugal force
 - (viii) brake and indicated horsepower
 - (ix) work - energy - power

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 5: Erection Equipment

UNIT 2: Derricks

OPERATIONS

KNOWLEDGE

1. Selecting a derrick

- (a) Interpretation of drawings and specifications to determine:
 - (i) nature of job
 - (ii) size, weight and location of the loads
 - (iii) derrick capacities required and available
- (b) Effect of site conditions on derrick selection:
 - (i) supports and anchorages available
 - (ii) access for supply of steel
 - (iii) requirements of other contractors
- (c) Interpretation of Workmen's Compensation Board and Company standard regulations
- (d) General types, purposes, characteristics and size ranges of derricks:
 - (i) stiffleg and guy derricks
 - (ii) railway car derricks
 - (iii) poles
 - (iv) floating derricks
 - (v) cableways
- (e) Construction features and characteristics of derricks:
 - (i) Jinniwick derrick
 - (ii) stiffleg derrick, framed at 90°
 - (iii) stiffleg derrick, framed at 60°, etc.
 - (iv) guyed stiffleg derrick
 - (v) guy derrick
- (f) Relationship between boom and mast length in derricks
- (g) Special characteristics of steel erector's guy derricks, compared with ordinary guy derricks
- (h) Construction features and characteristics of poles:
 - (i) simple pole or gin pole
 - (ii) dutchman
 - (iii) pair of poles
 - (iv) gallows frame
 - (v) "A" frame or sheerlegs
 - (vi) tripod
 - (vii) basket pole
 - (viii) Chicago boom
 - (ix) stack rig
 - (x) davit
 - (xi) guyless derrick (counterpoised boom)
 - (xii) other poles or booms

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 5: Erection Equipment

UNIT 2: Derricks

OPERATIONS

KNOWLEDGE

1. Selecting a derrick
(cont'd)

- (j) Construction features and characteristics of railway derrick cars:
 - (i) single boom
 - (ii) double boom
- (k) Types, purpose and function of floating derricks:
 - (i) "A" frame mast
 - (ii) "A" frame boom
 - (iii) fully revolving
- (l) Effects of heeling of barge mounting on:
 - (i) operating radius
 - (ii) slewing (swinging)
- (m) Construction features and characteristics of ropeways, cableways, highlines and tramways:
 - (i) gravity reeving
 - (ii) English or Telfer reeving
 - (iii) union purchase reeving (tightlining)
 - (iv) lidgerwood reeving
 - (v) travelift reeving
 - (vi) tramway reeving
 - (vii) reeving for spinning cables of suspension bridges
- (n) Limitations on span, and capacity for various types of cableway
- (o) Types, purpose and function of cableway carriages (bicycles)
- (p) Construction features and characteristics of towers and supports for ropeways, cableways, highlines and tramways:
 - (i) fixed towers, end and intermediate
 - (ii) travelling towers, on radial track
 - (iii) luffing towers
 - (iv) "A" frame towers
 - (v) gallows frame towers
 - (vi) rope saddles
- (q) Construction features and characteristics of supports for derricks:
 - (i) traveller carriages
 - (ii) creeper carriages or frames
 - (iii) rail trucks
 - (iv) towers
 - (v) pile groups
 - (vi) concrete slabs
 - (vii) brackets (Chicago booms)
 - (viii) grillages and mudsills
 - (ix) barges, pontoons, other floating equipment
 - (x) columns and beams in buildings

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 5: Erection Equipment

UNIT 2: Derricks

OPERATIONS

KNOWLEDGE

1. Selecting a derrick
(cont'd)

- (r) Types, purpose and application of derrick anchors or anchorages:
 - (i) U bolt, grouted in rock holes or cast in concrete
 - (ii) eyebolts, grouted or wedged in rock or cast in concrete
 - (iii) wire rope choker, grouted in rock or cast in concrete
 - (iv) wire rope choker, round building column, tree stump or other heavy object
 - (v) deadman or buried anchorages
 - (vi) piles, single or groups
 - (vii) picket groups
 - (viii) naval or marine anchors
 - (ix) tiedown hooks to beams or girders
 - (x) wire mesh and pegs
 - (xi) deck hoists and spuds, floating derricks
- (s) Nomenclature, features and functions of common derrick components:
 - (i) load falls
 - (ii) boom falls or topping lift
 - (iii) booms
 - (iv) masts
 - (v) bullwheels, bull sticks, slew lines
 - (vi) footblocks and distribution beams
 - (vii) stifflegs and laylegs
 - (viii) guys
 - (ix) sheaves and bearings
- (t) Importance of relationship between size of job and set-up costs of derrick
- (u) Considerations re efficiency of various boom and jib details
- (v) Importance of inspection of mechanical and structural conditions of derricks for defects:
 - (i) bent or broken members
 - (ii) missing lacing
 - (iii) cracked welds
 - (iv) loose bolts and rivets
 - (v) worn pins and bushings
 - (vi) loose and worn sheaves
 - (vii) worn and rusty ropes
 - (viii) other
- (w) Procedures for inspecting derricks prior to selection

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 5: Erection Equipment

UNIT 2: Derricks

OPERATIONS

KNOWLEDGE

1. Selecting a derrick
(cont'd)

- (x) Other considerations when selecting derricks
- (y) Importance of obtaining engineering assistance in the selection of derricks for unusual conditions
- (z) Mathematics:
 - (i) ratio and proportion to determine derrick size and capacity
 - (ii) Pythagorean theorem
 - (iii) formula to determine:
 - (1) area of circle
 - (2) circumference of an arc or circle
 - (3) length of belts and ropes for pulley/applications and tackle
 - (iv) techniques and formula to determine required lengths of booms
- (aa) Science:
 - (i) work, energy, power
 - (ii) centre of gravity
 - (iii) wheel and axle
 - (iv) screw jack
 - (v) pulley blocks and rope tackles
 - (vi) deflection of beams
 - (vii) columns, slender and short

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 5: Erection Equipment

UNIT 2: Derricks

OPERATIONS

KNOWLEDGE

2. Loading out a derrick

- (a) Interpretation of drawings and sketches to determine bill of parts to be shipped
- (b) Purpose and use of loading aids:
 - (i) dunnage and blocking
 - (ii) stakes
 - (iii) cinches, chains and tiedowns
- (c) Interpretation of loading rules and regulations for shipment by:
 - (i) road
 - (ii) rail
 - (iii) water
- (d) Procedures for computing shipping weights
- (e) Methods of loading and securing derrick shipments
- (f) Importance of protecting dismantled components:
 - (i) exposed bearings
 - (ii) machined surfaces
 - (iii) small parts
- (g) Results of improper loading out techniques:
 - (i) damaged parts
 - (ii) missing parts
 - (iii) delay

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 5: Erection Equipment

UNIT 2: Derricks

OPERATIONS

KNOWLEDGE

3. Erecting derricks

- (a) Interpretation of drawings and specifications to determine:
 - (i) access for steel
 - (ii) sequence of erection
 - (iii) capacity of proposed supports
 - (iv) locations requiring fewest moves of derrick and derrick boom
- (b) Examination of site for:
 - (i) access for steel
 - (ii) obstructions
 - (iii) requirements of other contractors
- (c) Need for engineering advice in determining capacity of proposed derrick supports and anchorages
- (d) Interpretation of Workmen's Compensation Board and Company standards and regulations
- (e) Procedures for assembly of derrick after unloading using:
 - (i) carriage or support
 - (ii) mast or pole
 - (iii) reeve tackles
 - (iv) anchor guys
 - (v) antitwisters on guys
 - (vi) anchoring footblocks with footropes
 - (vii) booms and jibs
- (f) Considerations when assembling derricks
- (g) Factors in the location of derrick guys
- (h) Importance of having derrick mast plumb
- (j) Effect of unequal guy lengths on tension in the guys
- (k) Considerations when locating guys for a guy derrick
- (l) Techniques for sharing load between guys for a heavy lift
- (m) Results of improper derrick erection
- (n) Importance of thorough check of derrick installation before making lift
- (o) Importance and procedure for making a test lift

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 5: Erection Equipment

UNIT 2: Derricks

OPERATIONS

KNOWLEDGE

4. Lifting with a derrick

- (a) Use of drawings and bills to check actual weight of a lift
- (b) Interpretation of Workmen's Compensation Board and Company standards and regulations
- (c) Importance of organizing and coordinating the work of the:
 - (i) hooker-on
 - (ii) signalman
 - (iii) connector
 - (iv) hoisting engineer
- (d) Methods of lifting with derricks
- (e) Function and methods of using tagline on the load
- (f) Procedures for communicating when lifting with derricks:
 - (i) hand signals
 - (ii) paddle signals
 - (iii) lights
 - (iv) bells and horns
 - (v) telephone and headset
 - (vi) loud hailer
- (g) Hazards when lifting in high winds
- (h) Hazards when rolling loads with a derrick
- (j) Technique of sharing load between several guys for a heavy lift
- (k) Considerations when using a guy derrick on the erection of a tall building:
 - (i) effect of long operating lines on overhauling the load and boom falls
 - (ii) value of working in the sectors between guys
- (l) Considerations when using a floating derrick:
 - (i) effect of heel on radius and swing
 - (ii) effect of tides and currents
 - (iii) effects of grounding

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 5: Erection Equipment

UNIT 2: Derricks

OPERATIONS

KNOWLEDGE

4. Lifting with a derrick
(cont'd)

(m) Science:

- (i) momentum
- (ii) velocity
- (iii) acceleration and deceleration
- (iv) centrifugal force
- (v) work, energy, power
- (vi) nature of friction
- (vii) wheel and axle (sheaves)
- (viii) screw jack
- (ix) hydraulic jacks
- (x) levers
- (xi) worm and wheel
- (xii) pulley blocks (load and boom falls)

5. Servicing and maintaining
derricks

- (a) Procedures for inspection of wire ropes
- (b) Methods of lubricating wire ropes
- (c) Procedure for inspecting sheaves, pins, axles and shafts
- (d) Characteristics of wear in derrick sheaves
- (e) Method of lubricating derrick sheaves
- (f) Techniques for inspecting derrick structures
- (g) Need for engineering advice before straightening bent members
- (h) Techniques of straightening or strengthening damaged members
- (i) Hazards of inadequate maintenance
- (j) Importance of setting up an adequate maintenance program for a derrick
- (l) Science:
 - (i) atmospheric corrosion
 - (ii) galvanic corrosion
 - (iii) types of lubricants and their uses

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 5: Erection Equipment

UNIT 3: Hoists and Winches

OPERATIONS

KNOWLEDGE

1. Selecting a powered hoist
("Hand Hoists" covered under
"Hand Tools", Block 2, Unit 5)

- (a) Interpretation of job drawings and specifications and manufacturers data to determine nature of lift or pull to be made
- (b) Considerations when inspecting site for access and other limitations
- (c) Types, characteristics and purposes of powered hoists:
 - (i) air driven (tugger)
 - (ii) derrick hoists
 - (iii) hoists for hauling
- (d) Nomenclature, function and features of hoist components:
 - (i) brakes
 - (ii) bearings
 - (iii) clutches (friction)
 - (iv) transmissions, including torque converters
 - (v) controls; manual, air, hydraulic
 - (vi) pawls and ratchets (dogs)
- (e) Other considerations in the selection of a hoist:
 - (i) number of drums
 - (ii) range of speeds and line pulls
 - (iii) line capacity of drums
 - (iv) swingers
 - (v) type of power
- (f) Relationship between line speed, line pull and amount of line on drum
- (g) Types of power used to drive hoists:
 - (i) air motor, direct or reversible
 - (ii) hydraulic ram or motor
 - (iii) steam engine
 - (iv) gasoline engine
 - (v) diesel engine
 - (vi) electric motor
- (h) Importance of mechanical and structural condition of the hoist
- (i) Common weaknesses or defects in powered hoists

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE
- GENERAL TRADE PRACTICE -

BLOCK 5: Erection Equipment

UNIT 3: Hoists and Winches

OPERATIONS

KNOWLEDGE

1. Selecting a powered hoist
(cont'd)

(j) Mathematics:

- (i) formula to determine line capacity of a given drum
- (ii) formula to determine rope lengths required:
 - a) working length
 - b) total length
- (iii) ratio and proportions
- (iv) solution of right angle triangle by Pythagoras theorem
- (v) formula to determine circumference of a circle
- (vi) formula to determine length of belts (length of rope in a tackle)

(k) Science:

- (i) laws of equilibrium
- (ii) work, energy, power
- (iii) brake and indicated horsepower
- (iv) ratchets
- (v) wheel and axle
- (vi) gear drives
- (vii) chain drives

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 5: Erection Equipment

UNIT 3: Hoists and Winches

OPERATIONS

KNOWLEDGE

2. Installing a hoist

- (a) Considerations when examining site for hoist location:
 - (i) access for hoist and lines
 - (ii) interference from operations of other contractors
 - (iii) clear view for hoist operator
 - (iv) availability of supports and anchorages
- (b) Effect of full drums on shipping weight of hoists
- (c) Importance of installation of antifreeze for winter work
- (d) Considerations in the selection of hitching points for lifting hoists
- (e) Methods of lifting hoists into position
- (f) Techniques for estimation of capacity of hoist anchorages
- (g) Procedures for anchoring hoists
- (h) Procedures for installation and alignment of hoists
- (i) Technique of attaching wire rope to hoist drums
- (j) Importance of minimizing fleet angle between first lead sheave and front drum of hoist
- (k) Effects of poor sheave alignment on running wire rope
- (l) Importance of checking all clips, bolts and lashings before making first lift
- (m) Procedures for installing signal equipment for communicating with hoist operator
- (n) Considerations re housing the hoist for protection of hoist and operator
- (o) Techniques of driving hand hoists with air or electric motors
- (p) Mathematics:
 - (i) computation of length of wire rope in a lashing
- (q) Science:
 - (i) types of lubricants and their uses
 - (ii) types of fuels and their uses
 - (iii) simple electric circuits

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 5: Erection Equipment

UNIT 3: Hoists and Winches

OPERATIONS

KNOWLEDGE

3. Operating a hoist

- (a) Techniques of communicating with the hoist operator
- (b) Importance and techniques for smooth, prompt action by hoist and operator
- (c) Need for hoist operator to stay at hoist controls during working hours
- (d) Techniques for spooling wire ropes on hoist drums
- (e) Importance of periodic inspection and maintenance on:
 - (i) hoist and anchorages
 - (ii) wire ropes and sheaves
- (f) Importance of prompt reporting of any defects in the hoist or ropes
- (g) Procedures for servicing hoists and ropes
- (h) Importance of an adequate supply of clean fuel for the hoist
- (i) Causes of overloads in hoists:
 - (i) excessive line pulls
 - (ii) impact on lines
- (j) Effects of overloads on hoists:
 - (i) broken lines and dropped loads
 - (ii) burst or collapsed drums
 - (iii) bent shafts
 - (iv) premature wear on moving parts
 - (v) failed bearings
 - (vi) overheated transmissions
- (k) Science:
 - (i) momentum
 - (ii) work, energy, power
 - (iii) acceleration, deceleration

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 5: Erection Equipment

UNIT 3: Hoists and Winches

OPERATIONS

KNOWLEDGE

4. Closing down a hoist
(dogging-off)

- (a) Importance of immobilizing hoist at end of shift
- (b) Procedures for using dogs (pawls) on drums
- (c) Techniques of immobilizing hoist engines, when necessary:
 - (i) remove ignition key
 - (ii) disconnect battery
 - (iii) shut off fuel
 - (iv) disconnect distributor arm
- (d) Hazards of leaving unmanned hoist in running order
- (e) Procedures for servicing and maintaining hoists and ropes
- (f) Techniques for storing hoists and ropes
- (g) Science:
 - (i) atmospheric corrosion
 - (ii) galvanic corrosion
 - (iii) types of lubricants, and their uses

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE
- GENERAL TRADE PRACTICE -

BLOCK 5: Erection Equipment

UNIT 4: Jacks

OPERATIONS

KNOWLEDGE

1. Selecting a jack

- (a) Interpretation of job drawings and specifications and manufacturers capacity charts to determine:
 - (i) load to be moved
 - (ii) distance to be moved
 - (iii) characteristics of available jacks
 - (iv) space available for jacks
 - (v) best location in structure for application of jacking load
 - (vi) number of jacks required
- (b) Inspection of site for access and other limitations
- (c) Design features and nomenclature of jacks and accessories for jacks:
 - (i) handles
 - (ii) controls
 - (iii) ram nuts and horsehoe shims
 - (iv) heads and toes
 - (v) hydraulic rams, solid and holed
- (d) Types of power used for driving jacks:
 - (i) hand and lever
 - (ii) hand pump, one or two stage
 - (iii) gasoline engine pump, one or two stage
 - (iv) electric motor drive pump
 - (v) air motor drive pump, one or two stage
 - (vi) air motor drive gear train
- (e) Types, characteristics and purposes of hand operated jacks:
 - (i) screw, plain
 - (ii) screw, differential
 - (iii) screw, gear and ratchet drive
 - (iv) ratchet (track)
 - (v) hydraulic
 - (vi) wedge and screw
 - (vii) screw and toggle
 - (viii) sand
 - (ix) ice
- (f) Limitations on capacity, shipping weight, working height and fleeting range for hand operated jacks
- (g) Special considerations in the design and use of sand jacks
- (h) Other considerations in the selection of hand operated jacks

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 5: Erection Equipment

UNIT 4: Jacks

OPERATIONS

KNOWLEDGE

1. Selecting a jack (cont'd)

- (i) Types, characteristics and purposes of powered jacks:
 - (i) screw (mechanical)
 - (ii) hydraulic, single or double acting
 - (iii) air jacks
- (j) Limitations on capacity, diameter, shipping weight, working height and fleeting range for power operated jacks
- (k) Characteristics and pressure ranges of fluids which may be used in hydraulic jacks:
 - (i) air
 - (ii) water
 - (iii) water and alcohol
 - (iv) oils (hydraulic fluid)
- (l) Importance of using clean hydraulic fluids
- (m) Nomenclature, function and features of fluid transmission equipment for independently powered hydraulic jacks:
 - (i) threads and couplings
 - (ii) valves; needle, reducing, one way
 - (iii) tubing; copper, hose
 - (iv) gauges
- (n) Types of special supports required to permit lateral movement of jacks:
 - (i) carriages
 - (ii) bearing plates on rollers
 - (iii) greased plates
- (o) Other considerations in the selection of powered jacks
- (p) Mathematics:
 - (i) calculation of load to be lifted
 - (ii) tables of measure:
 - English: linear, square, cubic and weight
 - Metric: linear, square, cubic and weight
 - conversion to other system
 - (iii) area of a circle
 - (iv) volume of a cylinder

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 5: Erection Equipment

UNIT 4: Jacks

OPERATIONS

KNOWLEDGE

1. Selecting a jack (cont'd)

(q) Science:

- (i) viscosity ratings of oils
- (ii) Pascal's principle - the transmission of pressure in liquids
- (iii) laws of equilibrium
- (iv) piston motion
- (v) ratchets and cams
- (vi) mechanical advantage of simple machines
- (vii) levers
- (viii) wheel and axle
- (ix) incline plane
- (x) screw jacks
- (xi) hydraulic jacks
- (xii) worm and wheel
- (xiii) gear drives
- (xiv) chain drives
- (xv) pressure due to head, velocity
- (xvi) flow through pipes

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 5: Erection Equipment

UNIT 4: Jacks

OPERATIONS

KNOWLEDGE

2. Setting up a jack

- (a) Examination of site and interpretation of engineering drawings and specifications for best jack location
- (b) Importance of engineering advice when selecting a jacking point on a structure
- (c) Procedures for installation of jacks
- (d) Methods of limiting movement of structure being jacked:
 - (i) vertical
 - shims
 - blocking
 - ram nuts
 - threaded follower rods and nuts
 - other
 - (ii) horizontal
 - guides
 - preventer and sway tackles
 - fixing other end
- (e) Importance of avoiding metal to metal contacts in jacking operations
- (f) Purpose and use of bearing plates for distribution of jacking loads
- (g) Procedures for linking several jacks for a big lift
- (h) Method and purpose of calibrating hydraulic gauges and jacks
- (i) Techniques of stiffening beams to withstand heavy jacking reactions:
 - (i) web stiffeners
 - (ii) lateral bracing or diaphragms
- (j) Procedures for setting up jacks when testing piles
- (k) Other considerations when installing jacks
- (l) Science:
 - (i) calculation of bearing pressures under head or toe of jacks

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE
- GENERAL TRADE PRACTICE -

BLOCK 5: Erection Equipment

UNIT 4: Jacks

OPERATIONS

KNOWLEDGE

3. Operating jacks

- (a) Technique of jacking operations:
 - (i) raising and following
 - (ii) fleeting and blocking
 - (iii) lowering and blocking
- (b) Limitations on net ram travel from compression of blocking and structure at start and end of stroke
- (c) Importance and techniques for organizing and coordinating jacking operations
- (d) Need to watch alignment of jacks and structure during a jacking operation
- (e) Special considerations when using sand jacks
- (f) Limitations of using ice for lowering loads
- (g) Techniques of regaining lost alignment
- (h) Servicing and minor maintenance of jacking equipment
- (i) Importance of cleanliness in jacking equipment, especially in hydraulic rams and fluids
- (j) Effects of extending jacks beyond the design range
- (k) Dangers of overloading jacks
- (l) Techniques of measuring jacking loads

4. Maintaining and storing jacks

- (a) Procedures for maintaining jacks
- (b) Methods of storing jacks
- (c) Value of special boxes for storing and shipping fittings from hydraulic jacks
- (d) Importance of inspection for common points of wear in jacking equipment
- (e) Need for cleanliness in jacking equipment
- (f) Science:
 - (i) types of lubricants and their uses
 - (ii) viscosity ratings of lubricants
 - (iii) lubricant deterioration
 - (iv) precision and non-precision measuring devices
 - (v) fits and clearances

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 5: Erection Equipment

UNIT 5: Equipment for Heavy Moving

OPERATIONS

KNOWLEDGE

1. Selecting heavy moving equipment

- (a) Interpretation of regulations limiting dimensions of heavy or bulky objects by:
 - (i) rails
 - (ii) road
 - (iii) cross country
 - (iv) water
- (b) Examination of load and interpretation of drawings and specifications to determine nature of job:
 - (i) length
 - (ii) width
 - (iii) height
 - (iv) weight
 - (v) distance to be moved
- (c) Methods of estimating weight of a heavy object:
 - (i) calculation
 - (ii) comparison
 - (iii) water displacement
 - (iv) city or department of highway scales
 - (v) ring gauges
 - (vi) hydraulic jacks and gauges
 - (vii) other methods
- (d) Examination of site and proposed route to determine access and facilities for offloading
- (e) General types, characteristics and purposes of heavy moving equipment:
 - (i) rail
 - (ii) rubber tired (road)
 - (iii) self-laying track (tracked)
 - (iv) rollers
 - (v) balls
 - (vi) floating
 - (vii) skids
- (f) Considerations when selecting general type of equipment to be used
- (g) Construction features, characteristics and capacities of rail equipment:
 - (i) bogies, trucks, cars, dollies
 - (ii) railway track
 - (iii) locomotives, and grade limitations

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK: Erection Equipment

UNIT 5: Equipment for Heavy Moving

OPERATIONS

KNOWLEDGE

1. Selecting heavy moving equipment (cont'd)

- (h) Construction features, capacities and characteristics of rubber tired (road) equipment:
 - (i) trucks
 - (ii) semi trailers
 - (iii) trailers and pole trailers
 - (iv) self-propelled trailers
 - (v) self-steering trailers
 - (vi) tractors
- (i) Considerations when selecting road equipment:
 - (i) maximum permissible grades of roads
 - (ii) required road surfaces
 - (iii) distribution of load between axles
- (j) Construction features, capacities and characteristics of cross-country or off-highway equipment (tracked):
 - (i) tracked trailers (Athey wagons)
 - (ii) tracked bogies
 - (iii) tractors and attachments
- (k) Construction features, capacities and characteristics of roller equipment for heavy moving:
 - (i) rollers in fixed frames
 - (ii) recirculating rollers in linked frames
 - (iii) rollers in travelling frames
 - (iv) pipe rollers
 - (v) wood rollers
 - (vi) runways for rollers
- (l) Construction features, capacities and characteristics of ball equipment for heavy moving:
 - (i) balls
 - (ii) runways
- (m) Characteristics, features and capacities of moving heavy objects by floating:
 - (i) on ships, barges, scows, floats, pontoons, lighters
 - (ii) heavy object scaled and floated
- (n) Types and construction features of special heavy duty slings and fittings for handling heavy loads

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE
- GENERAL TRADE PRACTICE -

BLOCK 5: Erection Equipment

UNIT 5: Equipment for Heavy Moving

OPERATIONS

KNOWLEDGE

1. Selecting heavy moving equipment (cont'd)

- (o) Construction features, characteristics and capacities of skid equipment for heavy moving:
 - (i) stone boats, sledges, sleighs
 - (ii) skids under standard equipment
 - (iii) greased skid plates
 - (iv) skid beams and rails
- (p) Importance of lubrication of mating surfaces when skidding heavy objects
- (q) Estimation of force required to move a heavy object
- (r) Comparison of motive power for moving heavy objects:
 - (i) hoists and tackles
 - (ii) jacks
 - (iii) locomotives
 - (iv) tractors, wheeled
 - (v) tractors, tracked
 - (vi) tugs
- (s) Other considerations in selecting equipment for heavy moving operations
- (t) Mathematics:
 - (i) techniques and formula to calculate weights, areas and unit pressures of heavy loads and moving equipment
 - (ii) solution of right angled triangles (slope, distance and rise)
- (u) Science:
 - (i) brake and indicated horse power
 - (ii) nature of friction
 - (iii) centre of gravity
 - (iv) inclined plane

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 5: Erection Equipment

UNIT 5: Equipment for Heavy Moving

OPERATIONS

KNOWLEDGE

2. Using equipment for moving heavy objects

- (a) Examination of site and route for clearances and access
- (b) Considerations in selecting points of support on the heavy object
- (c) Procedures for loading heavy objects
- (d) Methods of applying motive force to the heavy moving operation
- (e) Procedures for obtaining special permits for oversize highway movements
- (f) Responsibilities towards other traffic when moving heavy objects
- (g) Hazards of moving oversize shipments:
 - (i) collision
 - (ii) overhead wires
 - (iii) electric shock
- (h) Techniques of unloading or moving heavy cylindrical shipments by rolling
- (i) Methods of changing direction when travelling with heavy road or rail gantries
- (j) Techniques for restraining the heavy object once in motion using:
 - (i) snubbing lines or tackels
 - (ii) brakes on tractor and/or trailer
 - (iii) anchors
 - (iv) shims, wedges and blocking
 - (v) other
- (k) Hazards of losing control of a heavy object
- (l) Procedures for servicing and storing equipment for heavy moving
- (m) Science:
 - (i) pulley blocks

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 5: Erection Equipment

UNIT 6: Other Erection Equipment

OPERATIONS

KNOWLEDGE

1. Operating power sources
for construction equipment

- (a) Nomenclature, function and features of power sources for erection equipment:
 - (i) gasoline engines
 - (ii) diesel engines
 - (iii) electric motors
- (b) Interpretation of Manufacturers handbooks, data sheets and instructions
- (c) Principles of gasoline engines:
 - (i) two or four stroke
 - (ii) air or water cooled
- (d) Fundamentals of diesel engines:
 - (i) two or four stroke
 - (ii) air or water cooled
- (e) Principles of electric motors
- (f) Need for qualified advice when connecting or disconnecting electric motors
- (g) Techniques for starting engines:
 - (i) gasoline
 - (ii) diesel
 - (iii) electric
- (h) Special procedures for cold weather starting
- (i) Importance of antifreeze in cooling systems in winter months
- (j) Procedures for servicing and minor maintenance of power sources for erection equipment:
 - (i) fuel, oil and filters
 - (ii) injectors and spark plugs
 - (iii) coils and magnetos
 - (iv) batteries
 - (v) carburetors, water pumps, fuel pumps
 - (vi) fan belts
 - (vii) governors
 - (viii) fuses and switch gear
 - (ix) tires
 - (x) other
- (k) Importance of regular servicing of engines
- (l) Hazards of fire when fuelling engines
- (m) Significance of clean fuel to engine operation
- (n) Techniques for diagnosis of common faults in power sources for erection equipment
- (o) Importance of qualified advice and assistance in maintenance operations
- (p) Methods of stopping power sources for erection equipment
- (q) Procedures for storing engines

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE* -

BLOCK 5: Erection Equipment

UNIT 6: Other Erection Equipment

OPERATIONS

KNOWLEDGE

1. Operating power sources
for construction equipment
(cont'd)

- (r) Importance of covering entrance to exhaust
stack when stored outside
- (s) Science:
- (i) combustion and fuels
 - (ii) principles of internal combustion
engines
 - (iii) types of lubricants and their uses
 - (iv) simple electric circuits
 - (v) dry cells and storage batteries
 - (vi) simple electric motors
 - (vii) brake and indicated horsepower
 - (viii) simple generators ac and dc

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 5: Erection Equipment

UNIT 6: Other Erection Equipment

OPERATIONS

KNOWLEDGE

2. Operating erection power equipment

- (a) Types, capacities and features of other erection equipment (powered):
 - (i) air compressors
 - (ii) welding machines
 - (iii) trucks
 - (iv) outboard motors (boats)
 - (v) chain saws
 - (vi) fans (blower or exhaust)
 - (vii) electric generators
- (b) Interpretation of Manufacturers handbooks, data sheets and instructions
- (c) Application of Company maintenance program
- (d) Installation and alignment of powered erection equipment
- (e) Methods of starting powered erection equipment
- (f) Special considerations for cold weather starting
- (g) Procedures for servicing and minor maintenance of powered erection equipment
- (h) Methods of stopping power erection equipment
- (i) Considerations and procedures for storing powered erection equipment
- (j) Value of covered storage for powered erection equipment
- (k) Science:
 - (i) atmospheric corrosion
 - (ii) galvanic corrosion
 - (iii) types of lubricants and their uses
 - (iv) work, energy, power
 - (v) brake and indicated horse power
 - (vi) belt drives
 - (vii) chain drives
 - (viii) gear drives

AN ANALYSIS' OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 5: Erection Equipment

UNIT 6: Other Erection Equipment

OPERATIONS

KNOWLEDGE

3. Using other major items
of construction equipment

- (a) Types, purpose, construction features and characteristics of other major items of erection equipment:
 - (i) portable, temporary or mobile buildings for offices, tool rooms, change rooms, first-aid, stores, etc.
 - (ii) tool boxes
 - (iii) work boats, row boats, safety boats
- (b) Procedure for locating and erecting temporary buildings
- (c) Considerations when locating temporary buildings
- (d) Importance of covered storage for some tools and materials, e.g. wrenches and bolts
- (e) Minor maintenance needs of temporary buildings
- (f) Special features of tool boxes
- (g) Considerations when using tool boxes
- (h) Considerations with regard to weather and tide when using boats
- (i) Importance of provision of life jackets when using boats
- (j) Techniques of using boats for construction
- (k) Methods of propelling boats:
 - (i) hand, (oars, paddles or pole)
 - (ii) motor, (inboard or outboard)
- (l) Considerations in determining safe load for a boat
- (m) Importance of provision of breastline and oars on all boats
- (n) Methods of securing boats after use
- (o) Procedures for minor maintenance, care and storage of boats
- (p) Importance of marking Company name and/or colour on all equipment

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE
- GENERAL TRADE PRACTICE -

BLOCK 6: Erection Techniques

TABLE OF CONTENTS

UNIT 1.	Structures	Page	92
2.	Shipping and Handling		94
3.	Erection		96
4.	Field Fabrication Techniques		98
5.	Alignment		99

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 6: Erection Techniques

UNIT 1: Structures

OPERATIONS

KNOWLEDGE

1. Evaluating structural steel and platework structures

- (a) Type and structural characteristics of building frames:
 - (i) single storey beam and column
 - (ii) single storey with open web joists
 - (iii) multi-storey with beam and column
 - (iv) multi-storey with open web joists
 - (v) mill type building
 - (vi) packaged buildings
- (b) Elements and characteristics of frame building:
 - (i) corrugated floor deck system
 - (ii) curtain wall construction
 - (iii) battle-decking
 - (iv) composite floor and deck construction
- (c) Types and structural characteristics of bridges:
 - (i) simple beam, girder and truss spans
 - (ii) continuous beam, girder and truss spans
 - (iii) suspension bridges
 - (iv) cantilever bridges
 - (v) movable spans
 - (vi) arch bridges
 - (vii) army-type bridges
 - (viii) packaged bridges
- (d) Characteristics of miscellaneous steel structures:
 - (i) radio, T.V. and hydro masts
 - (ii) dock and powerhouse cranes
 - (iii) powerhouse gates
- (e) Type and structural characteristics of liquid storage vessels:
 - (i) cylindrical storage tanks
 - (ii) elevated spheres, oblate spheroids, and cylindrical tanks
- (f) Types of gas tight structures:
 - (i) flues, stacks and breechings
 - (ii) spheres and spheroids
 - (iii) floating roof tanks
- (g) Types of pressure vessels:
 - (i) digesters, fractional stills, boilers, evaporators, heat exchangers, bubble towers, cat crackers
 - (ii) penstocks, surge tanks, scroll cases

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 6: Erection Techniques

UNIT 1: Structures

OPERATIONS

KNOWLEDGE

1. Evaluating structural
steel and platework
structures (cont'd)

(h) Interpretation of drawings and/or erection
procedure specifications to determine:
 (i) erection methods and techniques
 (ii) job sequence
 (iii) location of material stockpiles
 (iv) equipment needed

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 6: Erection Techniques

UNIT 2: Shipping and Handling

OPERATIONS

KNOWLEDGE

1. Loading and unloading
steel and structural
plate

- (a) Interpretation of engineers' instructions, shipping bills and relevant handbooks to determine:
 - (i) load
 - (ii) height of lift
 - (iii) location on site
- (b) Types, purpose and operating characteristics of loading and unloading devices and equipment:
 - (i) bear paw clamp
 - (ii) a frame
 - (iii) side booms
 - (iv) screw clamps
 - (v) hooks
- (c) Considerations in the selection and use of loading and unloading devices and equipment
- (d) Methods of using unloading devices and equipment
- (e) Type, selection and method of placing dunnage
- (f) Types, purpose and use of slings:
 - (i) choker
 - (ii) spreaders
- (g) Factors affecting the choice of slings
- (h) Methods of slinging
- (i) Procedures for loading and unloading structural steel and plate
- (j) Results of improper handling
- (k) Mathematics:
 - (i) tables of weights and measures to calculate load
 - (ii) linear measurement
- (l) Science:
 - (i) work - energy - power
 - (ii) lever
 - (iii) stresses in slings

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 6: Erection Techniques

UNIT 2: Shipping and Handling

OPERATIONS

KNOWLEDGE

2. Piling

- (a) Interpretation of drawings to determine:
 - (i) place marks
 - (ii) location of pieces in final structure
 - (iii) location on site
- (b) Factors affecting placement and piling of structural steel and plate:
 - (i) location to job
 - (ii) accessibility
 - (iii) ground conditions
 - (iv) drainage
- (c) Procedures for piling materials
- (d) Importance of evaluating erection procedure when stacking materials
- (e) Results of improper piling

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICES -

BLOCK 6: Erection Techniques

UNIT 3: Erection

OPERATIONS

KNOWLEDGE

1. Slinging and hooking on

- (a) Interpretation of drawings and specifications to determine:
 - (i) piece marks
 - (ii) weight and size of piece
 - (iii) position of piece in finished structure
- (b) Consideration of sequence of erection
- (c) Types, purpose and capacity of slings:
 - (i) choker
 - (ii) spreaders
 - (iii) lashing
- (d) Types, characteristics, capacity and use of lifting devices
- (e) Methods of slinging and hooking on
- (f) Importance of proper slinging techniques to prevent:
 - (i) damage to sling
 - (ii) dropped load
- (g) Purpose and use of tag line
- (h) Types and use of signals:
 - (i) bells
 - (ii) hand
 - (iii) phones
- (i) Procedures for lifting and positioning structural steel and plate
- (j) Mathematics:
 - (i) weights and measures to calculate weight and size of piece
 - (ii) formula to compute safe working load of wire rope
- (k) Science:
 - (i) factor of safety

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 6: Erection Techniques

UNIT 3: Erection

OPERATIONS

KNOWLEDGE

2. Connecting steel

- (a) Identification and sequence of erection of members
- (b) Types, purpose and characteristics of fasteners
- (c) Types and purpose of connections:
 - (i) single header
 - (ii) double header
 - (iii) seat
- (d) Types, purpose and use of connecting equipment:
 - (i) spud wrenches
 - (ii) plate carriers
 - (iii) connecting bars
 - (iv) key plates
 - (v) bull pins
 - (vi) key channels
 - (vii) blank nuts
- (e) Methods of connecting steel:
 - (i) flange to flange
 - (ii) web to flange
 - (iii) web to web
- (f) Considerations in determining fastening technique:
 - (i) deck load
 - (ii) wind load
- (g) Results of improper connections:
 - (i) beam end-for-end
 - (ii) beam too high or low
- (h) Importance and use of scaffolds and ladders
- (i) Importance of adequate guying during erection
- (j) Importance and methods of maintaining alignment during erection
- (k) Climbing techniques
- (l) Importance of suitable working dress
- (m) Importance of temporary planking under working area
- (n) Mathematics:
 - (i) linear measurement to calculate lengths
 - (ii) weights and measures
- (o) Science:
 - (i) principle of turning moment
 - (ii) fits and clearances
 - (iii) tensile stress and strain
 - (iv) shear

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 6: Erection Techniques

UNIT 4: Field Fabrication Techniques

OPERATIONS

KNOWLEDGE

1. Field fabricating

- (a) Interpretation of drawings, specifications or engineers' instructions to determine:
 - (i) field holes
 - (ii) alterations to existing structure
 - (iii) new members and plates
- (b) Type, function and characteristics of field fabricating tools:
 - (i) air drill
 - (ii) electric drill
 - (iii) cutting outfit
 - (iv) welding equipment
 - (v) bridge reamer
 - (vi) other
- (c) Methods of using field fabrication tools and equipment
- (d) Procedures for field fabrication:
 - (i) field layout
 - (ii) field drilling
 - (iii) cutting
 - (iv) shrinking
 - (v) straightening members
- (e) Effects of improper field fabrication on:
 - (i) erection time
 - (ii) fitting and plumbing
- (f) Considerations before making alterations to existing structures
- (g) Mathematics: linear measurement to determine length and size of fabricated parts
- (h) Science:
 - (i) gases - acetylene oxygen, propane
 - (ii) types, uses and action of fire extinguishers
 - (iii) work - energy - power
 - (iv) bolted, rivetted and welded joints
 - (v) factor of safety

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 6: Erection Techniques

UNIT 5: Alignment

OPERATIONS

KNOWLEDGE

1. Positioning column bases

- (a) Interpretation of drawings and specifications to determine:
 - (i) centre-to-centre spacing of columns
 - (ii) allowable tolerances
- (b) Techniques in moving column bases, and bridge pier members:
 - (i) slogging
 - (ii) wedging
 - (iii) leverage
- (c) Method of shimming columns
- (d) Types, purpose and characteristics of grouts
- (e) Method of mixing and placing grout
- (f) Results of improper method of moving column anchors
- (g) Science: levers

2. Plumbing columns

- (a) Function, capacities and size of plumbing guys
- (b) Nomenclature, construction and use of wire rope fittings:
 - (i) clips
 - (ii) shackles
 - (iii) turnbuckles
- (c) Method of installing plumbing guys
- (d) Effects of improper installation of guys:
 - (i) bent column
 - (ii) excess plumbing time
- (e) Types, operation and use of plumbing devices and instruments:
 - (i) plumb bob
 - (ii) spirit level
 - (iii) transit
- (f) Procedures for plumbing columns
- (g) Importance of adherence to relevant codes
- (h) Causes and remedies of over run and under run
- (i) Mathematics: linear measurement to calculate guy length
- (j) Science: optical instruments

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 6: Erection Techniques

UNIT 5: Alignment

OPERATIONS

KNOWLEDGE

3. Adjusting lintels, girts
and elevator shafts

- (a) Interpretation of drawings and specifications to determine:
 - (i) allowable tolerance
 - (ii) masonry line
 - (iii) clearances
- (b) Techniques for checking line and level of lintels:
 - (i) chalk line
 - (ii) plumb bob
 - (iii) level
- (c) Procedures for adjustment using:
 - (i) shims
 - (ii) slotted holes
- (d) Use of cutting torches
- (e) Effects of improper alignment on:
 - (i) masonry alignment and plumbing
 - (ii) window frame fitting
- (f) Mathematics: linear measurement
- (g) Science:
 - (i) elementary scientific measurement
 - (ii) types, uses and action of fire extinguishers

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE
- GENERAL TRADE PRACTICE -

BLOCK 7: Fastening Techniques

TABLE OF CONTENTS

UNIT 1. Welding	Page 102
2. Bolting	108
3. Rivetting	113
4. Tube Rolling	117
5. Heavy Structural Pins	119

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 7: Fastening Techniques

UNIT 1: Welding

OPERATIONS

KNOWLEDGE

1. Selecting electrodes

- (a) Interpretation of drawings and specifications to determine:
 - (i) joint preparation and position
 - (ii) electrode specification and size
 - (iii) size and type of weldment
 - (iv) surface finish of weldment
 - (v) electrode requirements
- (b) Interpretation of standard welding definitions and standard welding symbols
- (c) Adherence to relevant codes and specifications
- (d) Types, purpose and characteristics of welding electrodes:
 - (i) carbon steel
 - (ii) alloy steel
- (e) Importance of visual identification and specification of electrodes
- (f) Science:
 - (i) physical properties of ferrous and non ferrous metals and alloys
 - (ii) classification and identification of steels

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 7: Fastening Techniques

UNIT 1: Welding

OPERATIONS

KNOWLEDGE

2. Selecting and using
welding equipment

- (a) Interpretation of drawings and specifications to determine type of shielded arc welding:
 - (i) arc spot welding
 - (ii) arc seam welding
 - (iii) submerged arc welding
 - (iv) stud welding
- (b) Types, operation and use of arc welding machines:
 - (i) gasoline
 - (ii) diesel
 - (iii) electrical:
 - (a) D.C.W. machine
 - (b) AC-DC rectifiers
 - (c) A.C. transformers
- (c) Familiarity with relevant standards for electric arc-welding machines
- (d) Procedures for servicing and minor maintenance of welding machines:
 - (i) fuel, oil and filters
 - (ii) injectors and spark-plugs
 - (iii) coils and magnetos
 - (iv) carburetors, waterpumps, fuel pumps
 - (v) fan belts
 - (vi) fuses and switch gear
 - (vii) governors
- (e) Procedures for cold weather starting
- (f) Diagnosis and remedies of common arc-welding machine troubles
- (g) Connection of and grounding electric welding machines to power source
- (h) Types, operation and use of electrode holders:
 - (i) insulated
 - (ii) uninsulated
- (i) Types, purpose and use of welding cables and grounds
- (j) Considerations when welding:
 - (i) welding current versus cable size
 - (ii) connecting cables to holder and machines
 - (iii) length of cables and grounds
 - (iv) selecting and connecting grounds
- (k) Methods of splicing weld cables
- (l) Importance of providing adequate scaffolding for welding

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 7: Fastening Techniques

UNIT 1: Welding

OPERATIONS

KNOWLEDGE

2. Selecting and using
welding equipment (cont'd)

- (m) Servicing, use and minor maintenance of:
 - (i) burning torches
 - (ii) air, oxygen, propane and acetylene hose
 - (iii) air grinders and brushes
 - (iv) arc gauges
 - (v) chipping hammers
- (n) Types, purpose and use of air compressors and air hose
- (o) Importance of proper air supply for pneumatic tools and arc gauges
- (p) Importance of protective equipment in welding:
 - (i) welding shields, safety glasses
 - (ii) use of protective clothing and safety hats
- (q) Importance of providing first aid treatment for arc burns to eyes and body and electric shock
- (r) Mathematics:
 - (i) linear measurement to calculate cable lengths
 - (ii) formula for converting amps and volts to kilowatts and horsepower
- (s) Science:
 - (i) combustion and fuels
 - (ii) types of lubricants and their use
 - (iii) conductors and insulators
 - (iv) elementary circuitry
 - (v) amperage, voltage, resistance
 - (vi) Ohm's Law
 - (vii) voltage drop and its measurement
 - (viii) voltmeter, ammeter, ohmmeter
 - (ix) simple electric motor
 - (x) induction coil
 - (xi) simple generators AC and DC
 - (xii) transformers - construction, efficiency, uses
 - (xiii) measurement of power and energy
 - (xiv) preparation, properties, storage and uses of gases - propane, oxygen and acetylene

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 7: Fastening Techniques

UNIT 1: Welding

OPERATIONS

KNOWLEDGE

3. Welding

- (a) Fundamentals of manual arc welding of carbon and alloy steel:
 - (i) welding sequence
 - (ii) effect of joint design
 - (iii) rate of deposition
 - (iv) types of electrodes and uses
- (b) Terminology and identification of plate and structural shapes, elements of members and symbols
- (c) Types, purpose and use of various plate and structural joints and connections
- (d) Layout procedures for connecting pipes and other shapes to cylindrical, spherical and ellipsoidal vessels perpendicular to and angular to the shells of vessels
- (e) Effect of voltage, amperage, polarity and arc length
- (f) Type, function and characteristics of welds
- (g) Fusion and penetration of welds
- (h) Effects of wind, temperature and moisture during welding
- (i) Importance of proper storage methods and use of Electrode Ovens:
 - (i) effect of moisture
 - (ii) prolonged heat
 - (iii) estimation of amount of electrodes required at work source
- (j) Purpose and techniques for preheating, post heating and stress relieving
- (k) Methods of controlling distortion during welding:
 - (i) mechanical control
 - (ii) welding procedure
- (l) Proper fitting and aligning for welding
- (m) Residual stresses and peening:
 - (i) peening hammers
 - (ii) pneumatic tools
- (n) Size and strength of welds
- (o) Effects and causes of porosity, undercut, cracks and slag inclusions in weldments
- (p) Flame cutting and carbon arc gouging
- (q) Importance of surface preparation of weldments
- (r) Effects and causes of overwelding

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 7: Fastening Techniques

UNIT 1: Welding

OPERATIONS

KNOWLEDGE

3. Welding (cont'd)

- (s) Types, purpose and use of scaling hammers:
 - (i) chipping hammers
 - (ii) power brushes
 - (iii) power grinders
 - (iv) arc gougers
- (t) Importance, purpose and method of back chipping and arc gouging of weld seams
- (u) Results of welding in confined areas (Fire and Respiratory protection)
- (v) Results and requirements when welding in refineries, chemical plants and congested areas:
 - (i) types and use of fire extinguishers
 - (ii) hot work permits
 - (iii) fire guard
 - (iv) explosivometers
- (w) Hazards when welding on or in vessels or tanks that have contained volatile liquids or combustible materials
- (x) Mathematics:
 - (i) linear and angular measurement for layout
 - (ii) conversion of decimal and fractional values
 - (iii) calculation of perimeter of a square, rectangle and triangle for layout
 - (iv) Pythagoras theorem
 - (v) calculation of circumference of circle
 - (vi) length of arc of a circle
 - (vii) area of a square, rectangle, triangle and a circle

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 7: Fastening Techniques

UNIT 1: Welding

OPERATIONS

KNOWLEDGE

3. Welding (cont'd)

(y) Science:

- (i) combustion and fuels
- (ii) composition of air
- (iii) types of lubricants and uses
- (iv) ferrous and non ferrous alloys
- (v) heat treatment of steels
- (vi) classification of steels
- (vii) preparation, properties, storage and uses of gases - acetylene, oxygen
- (viii) thermal expansion and contraction
- (ix) heat transfer - conduction
- (x) humidity and its measurement
- (xi) conductors and insulators
- (xii) elementary circuitry
- (xiii) amperage, voltage, resistance
- (xiv) Ohm's Law
- (xv) voltage drop - its measurement
- (xvi) voltmeter, ammeter, ohmmeter
- (xvii) simple electric motor
- (xviii) induction coil
- (xvix) simple generators AC and DC
- (xx) transformers - construction, efficiency, uses
- (xxi) measurement of power and energy
- (xxii) stresses - tensile, compressive and shear
- (xxiii) strain - tensile, compressive and shear
- (xxiv) yield strength
- (xxv) ultimate strength - tensile, compression and sheer
- (xxvi) stiffness - ductility and malleability
- (xxvii) factor of safety
- (xxviii) testing of materials for strength and structure
- (xxix) Types, uses and action of fire extinguishers

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 7: Fastening Techniques

UNIT 2: Bolting

OPERATIONS

KNOWLEDGE

1. Selecting bolts

- (a) Interpretation of drawings and specifications to determine:
 - (i) joint design
 - (ii) number of bolts required
 - (iii) size and type of bolt and washers
- (b) Terminology and identification of structural and plate shapes
- (c) Interpretation of relevant structural codes and hand books dealing with bolted connections
- (d) Types, purpose and characteristics of structural bolts, tensile bolts, anchor bolts, washers and gaskets:
 - (i) standard structural bolts and washers
 - (ii) high strength bolts and hardened washers
 - (iii) high strength bearing bolts or interference-body bolts
 - (iv) bent bolts
 - (v) stud bolts
 - (vi) bevel washers
 - (vii) ferrous and non-ferrous gaskets
 - (viii) others
- (e) Nomenclature and importance of visual identification of bolts and nuts
- (f) Methods of specifying type number and dimensions of bolts when ordering
- (g) Factors affecting serviceability of bolts
- (h) Allowable stresses for bolts in tension, bearing, compression, bending, bearing and shear
- (i) Mathematics:
 - (i) linear measurement and formula for calculating bolt length and thread length
- (j) Science:
 - (i) friction
 - (ii) stresses - tensile, compressive and shear
 - (iii) strain - tensile, compressive and shear
 - (iv) yield point
 - (v) ultimate strength
 - (vi) factor of safety
 - (vii) bolted, rivetted and welded joints

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 7: Fastening Techniques

UNIT 2: Bolting

OPERATIONS

KNOWLEDGE

2. Selecting bolting tools
and equipment

- (a) Interpretation of drawings and specifications to determine type of bolting:
 - (i) type of bolts, nuts, washers and gaskets
 - (ii) torque on bolts
 - (iii) location and type connection
- (b) Types, operation and use of bolting equipment
 - (i) hand wrenches
 - (ii) impact and torque wrenches
- (c) Types, operation and use of:
 - (i) air compressors and receivers
 - (ii) air hose and accessories
 - (iii) pressure regulators
 - (iv) manifolds and whips
- (d) Types, purpose and use of drilling and reaming equipment:
 - (i) reversible and non-reversible heavy duty drills and accessories
 - (ii) close quarter drills and accessories
- (e) Importance of proper size of air hose and air supply for air tools
- (f) Use of air pressure pocket gauge
- (g) Relationship of speed and power of air tool to drop in air pressure
- (h) Effect of and remedy for moisture in compressed air lines:
 - (i) after coolers
 - (ii) moisture separators
 - (iii) cold weather
 - (iv) alcohol, antifreeze
- (i) Causes and recommended remedies for low air pressure at the tool
- (j) Servicing and minor maintenance of:
 - (i) bolting and drilling equipment
 - (ii) air compressors
 - (iii) air hose
- (k) Calibration of power torque wrenches
- (l) Importance of providing adequate scaffolding for bolting
- (m) Mathematics:
 - (i) formula to calculate torque
 - (ii) linear measurement to calculate hose lengths

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 7: Fastening Techniques

UNIT 2: Bolting

OPERATIONS

KNOWLEDGE

2. Selecting bolting tools
and equipment (cont'd)

(n) Science:

- (i) torque
- (ii) work - power - energy
- (iii) bolted joints
- (iv) air pressure and its measurement

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 7: Fastening Techniques

UNIT 2: Bolting

OPERATIONS

KNOWLEDGE

3. Bolting

- (a) Interpretation of drawings and specifications to determine:
 - (i) type and number of bolts, nuts, washers and gaskets
 - (ii) torque on bolts
 - (iii) location and type connections
- (b) Terminology and identification of connection clips, splices and gusset plates
- (c) Terminology and identification of structural and plate shapes, elements of members and symbols
- (d) Procedures and fundamentals of bolting
- (e) Importance of and methods of proper alignment of members being connected:
 - (i) fair - up holes with pins
 - (ii) bolting sequence
 - (iii) fitting and assembly
- (f) Importance of clean contact surfaces - oil, burrs, scales, etc.
- (g) Methods of laying out for drilling and reaming:
 - (i) templates and patterns
 - (ii) edge distance tolerances for bolt holes
- (h) Procedures for drilling and reaming of holes
- (i) Bolt tension and torque values for various size bolts
- (j) Importance of proper bolt tension and of following wrench manufacturers recommendations for operation:
 - (i) turn-of-nut method
 - (ii) turn-of-nut method modified
 - (iii) calibrated torque wrenches
- (k) Effects on calibrated torque wrenches by:
 - (i) bolt thread condition
 - (ii) lubrication of bolt
 - (iii) efficiency of air tool
 - (iv) air pressure
 - (v) human error
- (l) Identification symbol of bolting crew on completed connection
- (m) Importance of "touch-up" of bolts previously tightened
- (n) Importance of impact wrench capacity and air supply to perform the required tightening in the specified time

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 7: Fastening Techniques

UNIT 2: Bolting

OPERATIONS

KNOWLEDGE

3. Bolting (cont'd)

(o) Mathematics:

- (i) linear measurement to calculate bolt and thread length
- (ii) formula to calculate torque
- (iii) calculation of effective bearing area

(p) Science:

- (i) torque
- (ii) work - power - energy
- (iii) strength of materials
- (iv) nature of friction
- (v) levers
- (vi) reactions at supports
- (vii) graphical solution of frameworks
- (viii) bolted joints
- (ix) stresses - tensile compressive shear
- (x) strain - tensile compressive shear
- (xi) yield strength and elongation
- (xii) ultimate strength
- (xiii) factor of safety
- (xiv) torsional stress
- (xv) bending moment and shear force diagrams
- (xvi) bending and shear stresses in beams
- (xvii) air pressure and its measurement

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 7: Fastening Techniques

UNIT 3: Rivetting

OPERATIONS

KNOWLEDGE

1. Selecting rivets

- (a) Interpretation of drawings and specifications to determine:
 - (i) joint design
 - (ii) number of rivets required
 - (iii) size and type of rivets required
- (b) Terminology and identification of structural and plate shapes
- (c) Relevant structural codes, specifications and hand books dealing with rivetted connections
- (d) Types, purpose and characteristics of rivets:
 - (i) button-head
 - (ii) high button head (acorn)
 - (iii) countersunk head
 - (iv) round top counter-sunk head
 - (v) cone head
 - (vi) pan head
- (e) Nomenclature and importance of visual identification of rivets
- (f) Methods of specifying type, number of rivets and dimensions when ordering
- (g) Factors affecting serviceability of rivets
- (h) Allowable stresses for rivets in tension, compression, bending, bearing and shear
- (i) Conventional drawing symbols for field rivetting
- (j) Mathematics:
 - (i) linear measurement and formula for calculating rivet length
- (k) Science:
 - (i) stresses - tensile, compressive and shear
 - (ii) yield point
 - (iii) ultimate strength
 - (iv) factor of safety
 - (v) bolted, rivetted and welded joints

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 7: Fastening Techniques

UNIT 3: Rivetting

OPERATIONS

KNOWLEDGE

2. Selecting rivetting tools
and equipment

- (a) Interpretation of drawings and specifications to determine:
 - (i) type and number of rivets required
 - (ii) location and type connection
 - (iii) size of rivets
 - (iv) hot or cold driven rivets
- (b) Types, operation and use of rivetting equipment
- (c) Types, operation and use of auxilliary equipment:
 - (i) air compressors and receivers
 - (ii) air hose and accessories
 - (iii) pressure regulators
 - (iv) manifolds and whips
 - (v) welding equipment
 - (vi) rivet heating equipment
 - (vii) caulking and hand tools
- (d) Types, purpose and use of drilling and reaming equipment:
 - (i) reversible and non-reversible heavy duty drills and accessories
 - (ii) close quarter drills and accessories
- (e) Servicing and minor maintenance of rivetting equipment and accessories
- (f) Importance of proper size air hose and air supply for air tools
- (g) Causes and proposed remedies for low air pressure at the tool
- (h) Effect of, and remedy for moisture in compressed air lines:
 - (i) aftercoolers
 - (ii) moisture separators
 - (iii) cold weather
 - (iv) alcohol, antifreeze
- (i) Relationship of power of rivetting hammer to drop in air pressure
- (j) Use of air pressure pocket gauge
- (k) Importance of providing adequate scaffolding for rivetting
- (l) Mathematics:
 - (i) linear measurement to calculate hose lengths
- (m) Science:
 - (i) work - power - energy
 - (ii) rivetted joints
 - (iii) air pressure and its measurements

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 7: Fastening Techniques

UNIT 3: Rivetting

OPERATIONS

KNOWLEDGE

3. Rivetting

- (a) Interpretation of drawings and specifications to determine:
 - (i) type, size and number of rivets
 - (ii) location and type connection
 - (iii) hot or cold driven rivets
- (b) Terminology and identification of connection clips, splices and gusset plates
- (c) Terminology and identification of structural and plate shapes, elements of members and symbols
- (d) Procedures and fundamentals of rivetting:
 - (i) heating
 - (ii) throwing
 - (iii) driving
 - (iv) bushing
 - (v) busting
 - (vi) maximum and minimum driving temperatures
- (e) Importance of and methods of proper alignment of members being connected:
 - (i) fair-up holes
 - (ii) rivetting sequence
 - (iii) fitting and assembly
- (f) Importance of clean contact surfaces - oil, burrs, scale, etc.
- (g) Methods of laying out for drilling and reaming in the field:
 - (i) templates and patterns
 - (ii) edge distance tolerances for rivet holes
- (h) Hot versus cold driven rivets
- (i) Importance of tight fully driven rivets with heads in full contact with the surface of members being connected
- (j) Identification symbol of rivetting crew on completed connection
- (k) Importance of rivetting tool capacity and air supply to perform the required rivetting in the specified time
- (l) Mathematics:
 - (i) linear measurement and formula to calculate rivet

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 7: Fastening Techniques

UNIT 3: Rivetting

OPERATIONS

KNOWLEDGE

3. Rivetting (cont'd)

(m) Science:

- (i) work - power - energy
- (ii) strength of materials
- (iii) nature of friction
- (iv) reactions at supports
- (v) graphical solution of frameworks
- (vi) rivetted joints
- (vii) stresses - tensile, compressive, shear
- (viii) strain - tensile, compressive, shear
- (ix) yield strength
- (x) ultimate strength
- (xi) factor of safety
- (xii) bending moment and shear force diagrams
- (xiii) bending and shear stresses in beams
- (xiv) heat treatment of steels
- (xv) thermal expansion and contraction
- (xvi) air pressure and its measurement

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 7: Fastening Techniques

UNIT 4: Tube Rolling

OPERATIONS

KNOWLEDGE

1. Selecting tube rolling equipment

- (a) Interpretation of drawings and specifications to determine:
 - (i) location of tubes
 - (ii) number, type, diameter, gauge and length of tubes
 - (iii) tube sheet thickness
- (b) Types, operation and use of tube rolling and auxilliary equipment, for boilers, condensers, heat exchangers and others:
 - (i) air motors and compressors
 - (ii) expanders, rolls, mandrels
 - (iii) heads and universal joints
 - (iv) angle and parallel gear drives
 - (v) calipers
 - (vi) flexible drive shafts
 - (vii) air hose and accessories
 - (viii) hand wrenches
- (c) Types, operation and use of tube cleaning and removal equipment
 - (i) air motors and compressors
 - (ii) tube cleaner, cutter and brush heads
 - (iii) flexible drive shafts
 - (iv) tube removal tools
- (d) Importance of proper size of air hose and air supply for air motor
- (e) Use of air pressure pocket gauge
- (f) Relationship of speed and power of air motor to drop in air pressure
- (g) Causes and proposed remedies for low air pressure at the air motor
- (h) Effect of and remedy for moisture in compressed air lines:
 - (i) aftercoolers
 - (ii) moisture separators
 - (iii) cold weather
- (i) Method of ordering expanders
- (j) Minor maintenance and servicing of tube rolling equipment
- (k) Mathematics:
 - (i) linear measurement to calculate hose lengths
- (l) Science:
 - (i) air pressure and its measurement
 - (ii) gear drives
 - (iii) work - power - energy
 - (iv) torque

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 7: Fastening Techniques

UNIT 4: Tube Rolling

OPERATIONS

KNOWLEDGE

2. Rolling tubes

- (a) Interpretation of drawings and specifications to determine:
 - (i) location of tubes
 - (ii) number, type, size and gauge of tubes
 - (iii) tube sheet thickness
- (b) Interpretation of codes, specifications and handbooks dealing with tubes, tube installing and rolling
- (c) Types, purpose and characteristics of tubes and tube sheets
- (d) Procedures and fundamentals of rolling and removing tubes
- (e) Care, storage and maintenance of tube rolling equipment
- (f) Importance of having two or more expanders during a rolling operation
- (g) Effects, causes and remedies for over and under rolled tubes
- (h) Use and benefits of automatic tube expansion control systems
- (i) Importance of replacing scarred or chipped rolls and mandrels
- (j) Importance of clean contact surfaces between expander and tube and tube sheet
- (k) Defects in tubes and effect on serviceability:
 - (i) scale and rust
 - (ii) bends and burrs
 - (iii) irregular surface
 - (iv) O.D. and I.D. tolerances
- (l) Mathematics: formula for calculating amount of tube expansion required for various size tubes and tube sheet thicknesses
- (m) Science:
 - (i) torque
 - (ii) work - power - energy
 - (iii) gear drives
 - (iv) air pressure and its measurement

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 7: Fastening Techniques

UNIT 5: Heavy Structural Pins

OPERATIONS

KNOWLEDGE

1. Installing pins

- (a) Interpretation of drawings and specifications to determine pin size and location:
 - (i) bridge pier members
 - (ii) suspended spans
 - (iii) eyebars
- (b) Types, purpose and characteristics of structural pins
- (c) Procedure for installing pins
- (d) Methods of aligning parts of structure to receive pin
- (e) Methods of supporting while driving pin
- (f) Description and purpose of devices for assisting the driving of pins:
 - (i) pilot nut
 - (ii) drive head
 - (iii) shrink fit pins with low temperature
- (g) Pin driving equipment:
 - (i) hydraulic ram
 - (ii) battering ram or headache ball
- (h) Science:
 - (i) thermal expansion and contraction

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE
- GENERAL TRADE PRACTICE -

BLOCK 8: Inspection and Testing

TABLE OF CONTENTS

UNIT 1: Inspection Procedures	Page 121
2: Test Procedures	131

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 8: Inspection and Testing UNIT 1: Inspection Procedures

OPERATIONS	KNOWLEDGE
1. Inspecting weldments (general)	<ul style="list-style-type: none">(a) Interpretation of drawings, specifications and relevant codes to determine:<ul style="list-style-type: none">(i) procedure and welder qualification(ii) material specifications(iii) service conditions(b) Interpretation of specifications and relevant codes to determine allowable weld defects(c) Fundamentals and procedures of arc welding(d) Visual inspection prior to, during and after welding(e) Face and edge examination for laminations, scabs, rust, edge preparation, alignment, gap(f) Importance of atmospheric conditions, procedure, cleaning, peening, preheat, filler metal, gauging, chipping, operation and condition of welding equipment(g) Dimensional accuracy of the weldment(h) Conformity to specification requirements regarding the extent, distribution, size, contour and continuity of welds(i) Weld appearance and surface flaws - cracks, porosity, unfilled craters, under-cutting(j) Types, use and purpose of mirrors, magnifying glass, borescope, scales and gauges for visual inspection(k) Importance of identifying the welds with welders symbol:<ul style="list-style-type: none">(i) stencils(ii) crayon(l) Mathematics: linear measurement for checking plate thickness, weld seam gap and defects(m) Science:<ul style="list-style-type: none">(i) thermal expansion and contraction(ii) amperage, voltage, resistance(iii) Ohm's law(iv) voltmeter, ammeter, ohmmeter(v) factor of safety

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 8: Inspection and Testing UNIT 1: Inspection Procedures

OPERATIONS

KNOWLEDGE

2. Metallographic Inspection
of weldments

- (a) Interpretation of drawings, specifications and relevant codes to determine allowable weld defects and number of samples required
- (b) Metallographic inspection by trepanning to determine:
 - (i) the distribution of non-metallic inclusions, cracks
 - (ii) the number of weld passes
 - (iii) the grain structure in the weld and fusion zone
- (c) Types, operation and use of trepanning equipment:
 - (i) core drills and trepanning tools
 - (ii) air motors and compressors
 - (iii) air hose and accessories
- (d) Method of preparing trepanned samples and interpreting the results
- (e) Purpose and method of identification of trepanned samples
- (f) Procedure and method of rewelding trepanned sample openings in weld seams
- (g) Science:
 - (i) hydrochloric acid (muriatic acid)
 - (ii) lacquer

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 8: Inspection and Testing UNIT 1: Inspection Procedures

OPERATIONS	KNOWLEDGE
3. Magnetic particle inspection of weldments	<ul style="list-style-type: none">(a) Interpretation of drawings, specifications and relevant codes to determine:<ul style="list-style-type: none">(i) allowable defects(ii) extent of inspection(b) Procedures for and characteristics of magnetic particle inspection(c) Types, purpose and use of basic equipment for setting up a magnetic field(d) Methods of adjusting current, voltage and applying indicating medium(e) Importance of identification and interpretation of the various defect patterns:<ul style="list-style-type: none">(i) cracks(ii) laminations and inclusions(iii) porosity(iv) lack of fusion(f) Science:<ul style="list-style-type: none">(i) distribution and concentration of charges(ii) amperage, voltage, resistance(iii) Ohm's law(iv) voltmeter, ammeter, ohmmeter(v) electromagnetism - magnetic fields

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 8: Inspection and Testing UNIT 1: Inspection Procedures

OPERATIONS

KNOWLEDGE

4. Penetrant inspection of weldments

- (a) Interpretation of drawings, specifications, relevant codes to determine:
 - (i) allowable defects
 - (ii) extent of inspection
- (b) Procedures for and characteristics of:
 - (i) fluorescent penetrant inspection
 - (ii) dye penetrant inspection
 - (iii) oil penetrant inspection
- (c) Types, purpose and use of equipment required for penetrant tests
- (d) Importance of identification of defects open to surface of weldments
 - (i) cracks
 - (ii) pores and leaks
 - (iii) nature of light and fluorescence
- (e) Science:
 - (i) capillary action
 - (ii) dyes

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 8: Inspection and Testing UNIT 1: Inspection Procedures

OPERATIONS	KNOWLEDGE
5. Radiographic inspection of weldments	<ul style="list-style-type: none">(a) Interpretation of drawings, specifications and relevant code to determine:<ul style="list-style-type: none">(i) allowable defects(ii) extent of inspection(b) Procedures for and characteristics of radiographic inspection<ul style="list-style-type: none">(i) x-ray(ii) gamma ray(c) Types, purpose and use of radiographic equipment:<ul style="list-style-type: none">(i) x-ray and gamma ray equipment(ii) film, penetrameters, cassettes, screens(iii) lead numbers and letters(iv) film viewers and timers(v) developing and fixing tanks(vi) temporary field dark rooms(vii) thermometer(viii) developer and fixer materials(ix) others(d) Importance of x-ray exposure factors:<ul style="list-style-type: none">(i) wave length (tube voltage)(ii) intensity (milleampere setting)(iii) ray source to film distance(iv) thickness of weldment(v) density of material(vi) size of source (focal spot)(vii) time of exposure(viii) type of film and screen(e) Techniques of film exposure:<ul style="list-style-type: none">(i) positioning and supporting radiation source and film(ii) developing, fixing and washing exposed film(iii) identification of film in relation to weldment radiographed(f) Preparation of welds for radiographic inspection:<ul style="list-style-type: none">(i) grinding(ii) chipping(g) Interpretation of developed film for macroscopic defects in weldments:<ul style="list-style-type: none">(i) cracks and slag inclusions(ii) porosity and undercut(iii) lack of penetration and fusion

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 8: Inspection and Testing UNIT 1: Inspection Procedures

OPERATIONS

KNOWLEDGE

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| 5. Radiographic inspection of weldments (cont'd) | (h) Importance of safety regulations during radiographing and hazards to operator and workmen
(i) Importance of protection of stored film
(i) daylight
(ii) scattered radiation
(j) Mathematics:
(i) linear measurement for locating film on structures and focal length
(ii) volumetric measurement for mixing developer and fixer
(k) Science:
(i) radioactivity
(ii) x-rays
(iii) gamma-rays
(iv) radiation
(v) amperage, voltage, resistance
(vi) voltmeter, ammeter, ohmmeter
(vii) cathode ray tubes |
| 6. Ultrasonic inspection of weldments | (a) Interpretation of drawings, specifications and relevant codes to determine:
(i) allowable defects
(ii) extent of inspection
(b) Procedures for and characteristics of ultrasonic inspection to detect, locate and measure:
(i) surface defects
(ii) subsurface defects
(c) Types, purpose and use of ultrasonic equipment
(d) Importance of interpretation of oscilloscope patterns to determine weld quality
(e) Science:
(i) electrical waves
(ii) frequency
(iii) electromotive force
(iv) ultrasonic
(v) cathode ray tube |

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 8: Inspection and Testing UNIT 1: Inspection Procedures

OPERATIONS	KNOWLEDGE
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7. Vacuum inspection of weldments	<ul style="list-style-type: none">(a) Interpretation of drawings and specifications and relevant codes to determine extent of inspection(b) Procedures for vacuum inspection of weldments(c) Types, purpose and use of vacuum inspection equipment:<ul style="list-style-type: none">(i) vacuum box(ii) soapsuds and flashlight(iii) air supply and related equipment(d) Importance of clean and flux-free surface for vacuum inspection(e) Importance of visual observation for detecting flaws during inspection<ul style="list-style-type: none">(i) unwelded areas(ii) cracks(iii) pinholes(f) Science: use of compressed air to create partial vacuum

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 8: Inspection and Testing UNIT 1: Inspection Procedures

OPERATIONS

KNOWLEDGE

8. Inspecting bolts

- (a) Interpretation of drawings and specifications to determine:
 - (i) type and size of bolts
 - (ii) number of bolts required
 - (iii) torque on bolts
 - (iv) type and size of washers
 - (v) code
- (b) Relevant codes and handbooks dealing with bolted connections
- (c) Visual inspection procedures to determine:
 - (i) clean contact surfaces
 - (ii) proper bolts and washers
 - (iii) required number bolts installed
 - (iv) proper alignment of holes and members
 - (v) sufficient bolt length and thread
 - (vi) hole size
- (d) Identification symbol of bolting crew and torque wrench number on completed connection
- (e) Removal of temporary or fit-up bolts
- (f) Use of bevelled washers on sloping surfaces and proper bearing
- (g) Restrictions on the use of drift pins:
 - (i) distortion of metal
 - (ii) enlargement of bolt hole
- (h) Calibration of torque wrenches by means of:
 - (i) manually operated torque wrenches
 - (ii) special calibrating equipment
- (i) tightening bolts by the one-turn method
- (j) Inspecting bolts tension using:
 - (i) manually operated torque wrench
 - (ii) pneumatic wrench
 - (iii) other practical methods
- (k) Importance of nut in tightening motion when torque measured
- (l) Steps to be taken when torque readings higher and lower than minimum tension are found
- (m) Types of failures:
 - (i) thread stripping
 - (ii) bolt fracture
 - (iii) shear
- (n) Allowable stresses for bolts in tension, compression, bending, bearing and shear
- (o) Bolt tension and torque values for various size bolts

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 8: Inspection and Testing UNIT 1: Inspection Procedures

OPERATIONS	KNOWLEDGE
8. Inspecting bolts (cont'd)	(p) Mathematics: <ul style="list-style-type: none">(i) formula for calculating torque(ii) calculation of bolt and thread length (q) Science: <ul style="list-style-type: none">(i) torque(ii) work - power - energy(iii) nature of friction(iv) levers(v) strength of materials(vi) bolted joints(vii) stresses - tensile, compressive, shear(viii) strain - tensile, compressive, shear(ix) yield strength and elongation(x) ultimate strength(xi) factor of safety(xii) torsional stress(xiii) bending moment and shear force diagrams(xiv) bending and shear stresses in beams(xv) air pressure and its measurement

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 8: Inspection and Testing UNIT 1: Inspection Procedures

OPERATIONS

KNOWLEDGE

9. Inspecting rivets

- (a) Interpretation of drawings and specifications to determine:
 - (i) type and size of rivets
 - (ii) number of rivets required
 - (iii) code
 - (iv) hot or cold driven rivets
- (b) Relevant codes and handbooks dealing with rivetted connections
- (c) Visual inspection to determine:
 - (i) clean contact surfaces
 - (ii) proper type and length of rivets
 - (iii) required number of rivets installed
 - (iv) proper alignment of holes and members
 - (v) hole and rivet diameters
- (d) Use of drift pins
 - (i) distortion of metal
 - (ii) enlargement of rivet hole
- (e) Inspection of rivets by the sounding method
- (f) Importance of tight, fully driven rivets with heads in full contact with the surface of the members being connected
- (g) Effect of heating rivets - maximum and minimum temperatures
- (h) Defects of rivets that affect serviceability - burrs, seams, scale, tolerances, offset heads
- (i) Allowable stresses for rivets in tension, compression, bending, bearing and shear
- (j) Mathematics:
 - (i) calculation of rivet length
 - (ii) calculation of effective bearing area
- (k) Science:
 - (i) strength of materials
 - (ii) rivetted joints
 - (iii) stresses - tensile, compressive, shear
 - (iv) strain - tensile, compressive, shear
 - (v) yield strength
 - (vi) ultimate strength
 - (vii) torsional strength
 - (viii) factor of safety
 - (ix) bending and shear stresses in beams
 - (x) heat treatment of steels
 - (xi) thermal expansion and contraction
 - (xii) heat measurement
 - (xiii) air pressure and its measurement

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 8: Inspection and Testing UNIT 2: Test Procedures

OPERATIONS	KNOWLEDGE
1. Testing of structures	<ul style="list-style-type: none">(a) Interpretation of drawings, specifications, and relevant codes to determine:<ul style="list-style-type: none">(i) service of vessel or structure(ii) material specifications(iii) type of test and/or test pressure or load(iv) duration of test pressure or load(v) tolerances(b) Hydrostatic test of tanks and pressure vessels to determine stability of supporting foundation and soundness of structure to operate as per design specifications:<ul style="list-style-type: none">(i) leaks in welds and appurtenances(ii) settlement and quality of foundation(iii) test of gauges and vents(iv) design pressure test(c) Hammer, pneumatic and vacuum testing of pressure vessels to determine the soundness of structure to operate as per design specifications:<ul style="list-style-type: none">(i) leaks in welds and appurenances(ii) test of gauges and vents(iii) design pressure or vacuum test(d) Testing storage tank, welded bottoms:<ul style="list-style-type: none">(i) visual examination of bottom plates for scars, drain holes, unwelded areas, slag removal(ii) vacuum test of welded seams(iii) water and dike method(e) Procedures for testing storage tank shells:<ul style="list-style-type: none">(i) hydrostatic test(ii) penetrating oil test(iii) vacuum test(iv) internal air pressure test(f) Procedures for testing storage tank roofs:<ul style="list-style-type: none">(i) internal air pressure(ii) external vacuum test(g) Methods of drawing a vacuum on a vacuum box<ul style="list-style-type: none">(i) gasoline or diesel motor intake manifold(ii) air ejector(iii) special vacuum pump(h) Procedures for testing storage tank rivetted bottoms by water test with bottom elevated on cribbing

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 8: Inspection and Testing UNIT 2: Test Procedures

OPERATIONS

KNOWLEDGE

1. Testing of structures
(cont'd)

- (i) Types, use and purpose of various types of testing equipment:
 - (i) standard pressure gauges
 - (ii) pressure recording gauges
 - (iii) strain gauges
 - (iv) manometers
 - (v) water pumps
 - (vi) compressors
 - (vii) water and air test lines
 - (viii) gate valves
 - (ix) linseed oil
 - (x) white wash
 - (xi) soapsuds
 - (xii) vacuum box
- (j) Importance of having test gauges calibrated and using proper maximum test pressure or vacuum
- (k) Importance of checking and methods used to test pressure relief valves, vacuum relief valves and breather vents on tanks and vessels
- (l) Significance of temperature of test water and atmospheric conditions during test
- (m) Soap-sud test of welds under pressure
- (n) Use of surveyor's level and transit to:
 - (i) check settlement
 - (ii) alignment
- (o) Importance of air compressor capacity for pneumatic tests
- (p) Availability of water supply and pump capacity
- (q) Application and use of high pressure water pumps
- (r) Importance of testing tanks and pressure vessels prior to painting or insulating
- (s) Methods of repairing leaks in welded, rivetted or bolted seams
- (t) Service and minor maintenance of:
 - (i) compressors and air hose
 - (ii) water pumps
- (u) Importance of care and safety during vacuum pneumatic and hydrostatic testing
- (v) Importance of test affidavits and stamping code on vessel or tank after test by government inspector

AN ANALYSIS OF
THE STRUCTURAL STEEL AND PLATE ERECTION TRADE

- GENERAL TRADE PRACTICE -

BLOCK 8: Inspection and Testing UNIT 2: Test Procedures

OPERATIONS	KNOWLEDGE
1. Testing of structures (cont'd)	(w) Mathematics: (i) volume of a cylinder, spheres, cones (ii) volume of a cylinder with elliptical or spherical ends (iii) claculation of hydrostatic head and test pressures (iv) conversion of cubic feet to gallons (x) Science: (i) air pressure and its measurement (ii) gas laws (iii) standard temperature and pressure (iv) pressure due to hydrostatic head (v) ductility (vi) factor of safety (vii) stresses in cylinders

